MEDICAL WASTE and HUMAN RIGHTS





Submission to the UN Human Rights Council

Special Rapporteur

September 2011

Health Care Without Harm

Written by

Ruth Stringer,
Health Care Without Harm

With contributions from

Arshad Altaf, Vanderbilt Institute for Global Health, Pakistan; Qazi Ali Athar, Environmental Attorney, Pakistan; Rico Euripidou, groundWork, South Africa; Merci Ferrer, Health Care Without Harm, Yuyun Ismawati, BaliFokus, Indonesia; Josh Karliner, Health Care Without Harm; Alejandra Livschitz, Health Care Without Harm; Mahesh Nakarmi, HECAF Nepal; Veronica Odriozola, Health Care Without Harm

About HCWH

Health Care Without Harm is an international coalition of more than 440 members in 52 countries that works to transform the health care sector so that it is no longer a source of harm to human health and the environment.

We collaborate with doctors, nurses, hospitals, health care systems, professional associations, NGOs, governments and international organizations to promote the development and implementation of safe and environmentally healthy practices, processes and products in the health care sector.

HCWH's areas of work include sustainable health care waste management, green building, reducing health care's climate footprint, and the substitution of hazardous chemicals used in hospitals with safer alternatives.

HCWH Offices

HCWH - Southeast Asia
Unit 330, Eagle Court Condominium
26 Matalino Street, Brgy. Central Diliman,
Quezon City 1100 Philippines
ph: +63 2 9287572 / fax: +63 2 9262649
e: sonia@hcwh.org
www.noharm.org/seasia

HCWH - Latin America
Tamborini 2838 CP 1429
Ciudad de Buenos Aires, Argentina
ph/fax: +54 11 4545 7204
e: info@saludsindanio.org
www.saludsindanio.org

HCWH - International Coordination
Tamborini 2838 CP 1429
Ciudad de Buenos Aires, Argentina
ph/fax: +54 11 4545 7204
e: alejandra@hcwh.org
www.noharm.org/global

HCWH - Europe
Rue de la Pepiniere B1000
Brussels, Belgium
ph: +49 6224 994871
ph: +32 2503 0481
e: anja.leetz@hcwh.org
www.noharm.org/europe

HCWH - USA and Canada
12355 Sunrise Valley Dr., Suite 680
Reston, VA 20191, USA
ph: +1 703-860-9790
fax: +1 703-860-9795
e: cfunkhouser@hcwh.org
www.noharm.org/us_canada

Contents

Introduction

The Special Rapporteur is mandated by Human Rights Council resolution 9/1 "to undertake, in consultation with the relevant United Nations bodies, organizations and the secretariats of relevant international conventions, a global, multidisciplinary and comprehensive study of existing problems and new trends of, and solutions to, the adverse effects of the trafficking and dumping of toxic and dangerous products and wastes on human rights, (...) with a view to making concrete recommendations and proposals on adequate measures to control, reduce and eradicate these phenomena" (OP 4).

In 2011, the Special Rapporteur, Mr. Calin Georgescu, chose to focus his thematic report on the sound management and disposal of medical waste. As part of his research, organisations with an interest in this field, including Health Care Without Harm, were contacted to see if they had any relevant information.

Improper healthcare waste management leads to the violation of numerous human rights, and HCWH staff, with the assistance of network members and waste management experts across Africa, South Asia and Latin America, quickly assembled a large body of information which was submitted to the Special Rapporteur for his consideration.

It rapidly became obvious not only that the volume of information was far too great for the Special Rapporteur to cover it in depth in his report, and that it painted a vivid picture of the harm done by this often neglected aspect of the global healthcare system. For this reason, Health Care Without Harm has chosen to publish this information to help highlight the issue and the importance of the Special Rapporteur's report.

The World Health Organisation has published Core Principles (2007) describing safe and sustainable healthcare waste management as a public health imperative and requiring all associated with it to support and finance it adequately. WHO rightly describe proper medical waste management as an integral part of a national healthcare system.

Unfortunately, it is still poorly funded and implemented, and represents an underestimated environmental and public health threat. A recent literature review (Harhay *et al*. 2009) came to the conclusion that over half the world's population are at risk from medical waste, either through impacts at work, in the environment or impacts on public health.

Unlike many other hazardous wastes, there is currently no international convention that directly covers medical waste management, so categorisation varies from country to country.

However, waste is most usually categorised according to the risk it holds. The majority- around 75%-85% of the waste produced by healthcare facilities- is similar to normal municipal waste and has no particular risk.

The next largest category is infectious waste (approximately 15-25%) of total waste. This may be subdivided into general infectious, sharps (1% of total waste), highly infectious, anatomical (1%) and pathological wastes.

Chemical and radioactive wastes, including pharmaceuticals, laboratory chemicals, cleaning agents, heavy metals such as mercury from broken thermometers, and pesticides with a variety of health and environmental effects. Pharmaceutical and chemical waste comprises about 3% of total medical waste and radioactive waste less than 1%.

Hospital wastewaters are often excluded from the list of medical wastes, but are also worth considering. Whereas municipal sewerage will contain pathogens, cleaning chemicals and

miscellaneous other contaminants such as road runoff, the effluent from healthcare facilities contain more drug-resistant pathogens, a greater variety of chemicals and more hazardous materials than domestic sewage.

Properly managed, healthcare waste should not cause any adverse impacts on human health or the environment. A variety of technologies are available that can disinfect, neutralise or contain the wastes and information on management is freely available (see eg Stringer& Emmanuel 2007, Pruess *et al*. 1999)

Nevertheless, the burden on healthcare systems, particularly in low to middle income countries is such that resources are often not available for the management of medical waste, with the exception of larger, privately operated healthcare centres. Governance systems are also likely to be less robust and corruption more ingrained.

In 2002, WHO carried out a survey of 22 developing countries and found that between 18 and 64% of healthcare facilities do not use proper healthcare waste management procedures (WHO 2004).

Properly managed, healthcare waste should not cause any adverse impacts on human health or the environment. A variety of technologies are available that can disinfect, neutralise or contain the wastes and information on management is freely available.

WHO's South East Asia Regional Office (SEARO) regards medical waste as a serious health threat in most of the countries in the region, often being "ill-managed at all stages of the life cycle and generally disposed of by inadequate incineration" (WHO & FAO 2006).

Manyele & Lyasenga (2010) surveyed low level healthcare centres in two municipalities in Dar Es Salaam, Tanzania. They found that, in one area, 70% of healthcare centres used poor quality incinerators, or burned waste in pits or on open ground; in another, 83% buried their waste in pits. Over half the disposal sites were unfenced and close to housing. Standard operating procedures were present in 9% of centres in one municipality and 47% in the other. Problems were also identified with waste segregation, colour coding, transportation and storage. They reported similar situations in South Africa, Mozambique, Swaziland and Kenya.

Hospitals illustrated here are not necessarily badly run. Indeed, having data to share about medical waste management can be proof that the subject is not neglected.

Lack of prioritisation and funding also means there is limited scientific information available on the harm done by medical waste. The majority of what is available relates to sharps waste. This absence of direct evidence makes it harder to gain recognition of the hazards posed by other sorts of wastes. Nevertheless, the extent of the problem is apparent. The accounts in this report show a widespread failure to treat medical waste properly, and to comply with the legislation that exists. This is backed up by the work of other reviewers (Harhay *et al*. 2009).

Given the dearth of scientific literature, the current overview supplements scientific information with "grey" literature, newspaper

articles and first-hand experience from individuals in different parts of the world. It has not been possible to conduct a comprehensive review, but does provide an indication of the ways that the improper medical waste management can impair people's basic human rights.

The report is divided into two sections: the first reviews the human rights in question at the global level and includes the listing of scientific references and newspaper articles. Scientific articles are cited in the text in the normal way; newspaper articles are not all cited in the text, but are included to give the reader the fullest possible picture. Where possible, URLs are provided.

Appendix 1 consists of a number of national snapshots. Again these come not from the countries with the worst situations but where local experts were able to provide input. It should be noted that the countries and hospitals described in this report have been chosen predominantly on the availability of first-hand accounts and from the information that could be gathered in the time available. Apart from language restrictions, many countries are not mentioned in this report because there are no data available, rather than because they have a safe and smoothly functioning system.

Conversely, hospitals illustrated are not necessarily otherwise badly run or their staff neglectful. Indeed, the mere fact of having data to share about medical waste management can be seen as an indication that the subject is not totally neglected.

It is true that unprofessional, corrupt and criminal behaviour does occur in the management of medical waste, as it does in all walks of life, and there are many thousands of hospitals that could and should improve their waste management. However, there may also be a number of reasons why good hospitals have bad waste management systems.

The lack of infrastructure and/or resources are the most common reasons for this. If a country has no waste collection or treatment system, there is little a hospital director can do, and when the per capita healthcare spending is under US$ 100 per year (as is the case, in over 1/3 of the world's countries (WHO 2011), it can be hard to spend a few thousand dollars per year to maintain a simple waste treatment system, or even to spare US $500 to build simple infrastructure such as a placenta pit if it is not specifically provided for in the hospital budget.

These problems need to be recognised and corrected at all levels if human rights are to be upheld.

The Right of Access To information

In the context of medical waste management, the right of access to information can be divided into two main areas: the information that people need to protect themselves from harm; and the information that researchers, regulators and policy makers need to make sure that medical waste is safely managed, legislation is complied with, and a clear evidence base built to optimise operations and to identify and eliminate systemic flaws.

Unfortunately, there is far too little information available to healthcare workers and other members of society, including those who are at high risk for being exposed to medical waste outside of the hospital environment, such as informal sector recyclers and sanitation workers in general, especially in places where this waste is liable to enter the municipal solid waste stream. This can have direct effects; Ramokate and Basu (2009) demonstrated that healthcare workers with access to documents about healthcare waste management reported good handling practices. Nurses had better access (91%) than doctors (15%), which tallied with the fact that nurses had significantly better knowledge of the issues than doctors.

Training is almost universally described as inadequate in reports about medical waste management. Even where awareness is good, such as in the hospital described by Ramokate and Basu (2009), only 32% of the study participants found out about medical waste management policies through seminars or courses.

Only 23% of Bangladeshi waste workers had received even the most basic information about health and safety in medical waste management, and the majority of these had received it from a local NGO, rather than their own employers. The general lack of understanding of the hazards was illustrated by both attitude and behaviour. People used containers including sharps containers to store food, and healthcare workers giving patients used hazardous waste bin liners to carry their personal belongings (Patwary *et al*. 2011c).

Iranian researchers found that there was no training on medical waste handling or the associated hazards in a sample of 15 private hospitals (Askarian *et al*. 2004). No training was given to doctors or other personnel in Serbia (Stankovic *et al*. 2008). Medical staff in 6 Nigerian hospitals were unaware of medical waste management regulations and hospital policies (Ndidi *et al*. 2009). In Lao PDR, many of the provincial hospitals provided training, but at the health centre level, this was only carried out in the capital (Phengxay *et al*. 2007).

South African researchers demonstrated that healthcare workers with access to documents about healthcare waste management had good handling practices. Nurses had better access than doctors, which tallied with the fact that nurses had significantly better knowledge of the issues than doctors.

In Tripoli, Libya, a survey of 300 medical waste handlers, working for a local contractor, found that only 7% had received training in waste handling, and 21% were immunised against

hepatitis B (Franka *et al*. 2009). Another survey, across 14 hospitals in 3 cities, found that 85% of personnel, from managers to cleaning staff, had no training or detailed information about their duties regarding waste management; 55% of medical staff were under-informed about waste management risks and procedures; and 90% of municipal waste handlers were unaware of the hazards of medical waste (Sawalem 2008).

As well as information about the production of waste and the health status of waste workers, there is also a need for information about the emissions from incinerators. Pollution from incinerators can have a direct impact on the local population through particulate pollution and contamination of nearby soils and food sources, as well as increasing the global burden of dioxins and other pollutants. The levels of monitoring, compliance control and information publication are currently extremely low, and information in many low to middle income countries is completely absent.

The Aarhus Convention is the global model for procedures in environmental regulation. It has its roots in the 1992 Rio Declaration and is based on three pillars: The right to information, public participation in decision making and access to environmental justice- that is, the right to a healthy environment.

It is unique in that members of the public are explicitly allowed to submit information to the Compliance Committee if they feel that Parties to the Convention are not meeting its standards, and is the parent Convention to the Kiev Protocol on Pollutant Release and Transfer Registers (PRTRs). The Kiev Protocol is binding on its parties and means that even private companies should submit information on their emissions.

However, the Aarhus Convention is regional and refers only to Europe. In other parts of the world, national freedom of information (FoI) legislation pertains, though there are many countries that do not yet have FoI legislation and where it is present, it varies both in scope and the effectiveness of implementation. Access can also be limited by cost or practical means. For example, access to information about the different waste treatment facilities in the UK requires either personal visits to the regional offices of the Environment Agency and/or fees for the collation of the information.

Aside from these legislative issues there is a more fundamental barrier to information about the generation of medical waste, its treatment and any hazards or harm associated with it; and that is that few data are being collected.

At the national level, often data are simply not gathered at all, since there is no imperative to do so without either a regulatory framework, or a financial motive. The USA has a medical waste tracking act (1988), but that was a reaction to the washing up of huge amount of medical and municipal waste on the coast of the Northeast states in 1987, and is the exception rather than the rule.

In low to middle income countries, the most normal state of affairs is that there are no regulations or guidelines on medical waste management, or that it they have been developed but have not been implemented. WHO does recommend that national legislation include specifications for record-keeping and reporting but when countries are struggling to implement programmes at all, this is not a priority and many of the workers responsible for waste management may not be literate.

Health and infection status of healthcare workers in the developing world is poorly monitored compared with richer countries and needle-stick injuries are generally regarded as under-reported.

Finally, where records do exist, the information is generally not present in a publicly accessible form. Paper-based records will be the norm outside of the high income countries and the resources or drive to collate them are simply not present. This is true even in countries with comparatively well structured systems, such as India.

A study of 12 countries in Asia provides an illuminating snapshot of the situation. Data on waste generation for Mongolia were only available for the capital city; from Laos there was only data from one hospital and there was no documentation at all in Myanmar. Other countries- Malaysia, Singapore, Philippines and Japan- had better systems but the researchers could not access the information (Ananth *et al*. 2010).

The primary information source for most researchers is the peer-reviewed scientific literature. Harhay *et al*. (2009) conducted a multilingual search of the scientific literature on medical waste in low to middle income countries published since 2000 and returned only 87 papers. Over half related to Asia, with most papers on India (12). The most papers found for other countries was 6 (Brazil) with 5 for each for Nigeria and South Africa, and 4 each relating to Iran and Turkey. No literature at all was found for many countries; only 6 of the 20 countries of the Americas were represented and only 10 out of the 53 nations of Africa.

Thus we find that, for a number of reasons, the right to information about medical waste issues is not enjoyed by the vast majority of the world's citizens, including many of those who seek to improve the situation.

The Right to a Healthy Environment

This is the right that is most demonstrably violated through poor medical waste management. Whilst hazardous waste production and disposal typically occurs in industrial areas outside urban and residential zones, healthcare facilities, pharmacies and clinics are close to where we live, in the heart of our cities, towns and villages. Here, then, is where the great majority of medical waste is disposed of.

Where infrastructure is lacking, be it in resource poor environments or in rural areas, on-site disposal is often employed. The World Health Organisation guidelines (also known as the Blue Book) (Pruess *et al*. 1999) describes simple pit systems for burial of waste, and placenta pits can biodegrade pathological waste. Small-scale incinerators are widely employed- though these generate their own problems, as will be discussed later.

In practice, open dumping and open burning are all too common, and even the modest cost of building a placenta pit is beyond the means of many a healthcare facility. In cities that barely cope with the ever growing quantities of municipal waste, local governments cannot organise special collection for medical waste. As a consequence, medical waste ends up disposed of with the municipal waste, which can mean it ends up on street corners, rough ground, and in rivers and unregulated landfills. This is the norm in many countries.

In cities that barely cope with the growing quantities of municipal waste, local governments cannot organise special collection for medical waste. As a consequence, medical waste ends up disposed of with the municipal waste, which can mean it ends up on street corners, rough ground, and in rivers and unregulated landfills.

Dumped Medical Waste

Dumping of medical waste often happens not because the systems to cope with it are not there, but also because it is often cheaper, or easier for hospitals or waste disposal contractors avoid them.

The appended newspaper articles provide information from a fraction of the countries in which medical waste dumping occurs. The greatest number of incidents are reported in India, where this is a daily occurrence. India has had clear bio-medical waste rules since 1988 (MoHSW 1988), with common treatment facilities charging 3 or 4 Rupees per bed per day to treat or dispose of the waste.

However, the current number of common treatment facilities (variously reported as 157 and 170) are not sufficient and a 2010 review of the work of the Central Pollution Control Board (CPCB) reported that only around half of the country's medical waste was collected and treated according to the rules. Out of 84,809 hospitals, 48,183 (57%) are using common bio-medical waste treatment facilities or have engaged other private agencies. It is estimated that 420,461kg of biomedical waste is produced

daily, and 240,682kg is treated (IIM 2010). The rest - around 180 tonnes per day, produced by over 36,000 facilities - is either disposed of with municipal waste, dumped illegally, or enters the recycling market. The pictures below are from Pondicherry, in the southern Indian State of Tamil Nadu, where garbage of all sorts is dumped by the truck station.

Figure 1. Medical and municipal waste dumped at Pondicherry truck station (Brooks Anderson)

In Kolkata, waste destined for the local biomedical waste treatment facility instead ended up on an illegal tip, where women were paid to sift through the waste for syringes and other recyclables. The syringes were sold for INR40 (US$ 0.85) per kilo. In Himachal Pradesh, an Indian state on the edge of the Himalayas, there are reports of medical waste being dumped in streams whose waters are used, untreated, for drinking by communities downstream.

Figure 2. A cow searches for food amongst the red bags of medical waste dumped near the truck station in Pondicherry, India (Brooks Anderson)

Several incidents have been reported in South Africa in the last year. The largest, in the Free State, and involving 1700 tonnes of medical waste dumped at 4 sites, has cost 53 million Rand (7.9M USD) to clean up and resulted 7 people representing 9 companies facing criminal charges. In addition, waste has been dumped in public areas in Guateng, Western Cape and KwaZulu Natal provinces in the last year.

In China, 21 dead babies were found in a lake; some had hospital identity tags and one was wrapped in plastic and labelled “medical waste”.

In China, medical waste has been dumped in Henan province, where a medical facility designed to treat waste 8 tonnes of waste from

700 facilities has in fact only been contracted by 4 facilities and receives around 200 kg per day. In another recent incident, 21 dead babies were found in a lake; some had hospital identity tags and one was wrapped in plastic and labelled "medical waste". Although the Chinese law does classify foetuses and dead babies as medical waste, many facilities return them to their families for cremation and the incident has naturally sparked calls for rethinking of how the bodies of newborns and the unborn should be treated.

There is also widespread concern about the level of pollution from China's many incinerators. Harhay *et al*. (2009) cite a 2007 USAID report describing China's medical waste management as "*curing at the front door and poisoning at the back*".

Figure 3. A dog finds some pathological waste on a Kathmandu street (Nakarmi/HECAF).

In Latin America too, dumping is a problem. Medical waste was found in the waste bins of the historic centre of Oaxaca, Mexico. Concern has also been raised about medical waste being mixed with ordinary waste in the dumps of Honduras and Nicaragua. In Brazil, it is estimated that 76% of towns dispose of medical waste and municipal wastes together at the municipal landfills (Da Silva *et al*. 2005).

The beaches of Bali, Indonesia, are regularly contaminated with syringes and other medical waste that washes down the rivers during the monsoon, from a variety of illegal dumping sites.

Figure 4. Discovered during a waste audit: a leg destined for disposal via the municipal system (Nakarmi/HECAF).

Nor is this exclusively a problem of the developing world; this happens even in the richest societies. Incidents of waste dumping are reported sporadically in places such as the US and Canada. In the past there have been numerous reports of medical waste washing up on the beaches of the United States. Recent incidents have been in New Jersey in 2009 and Hawaii in January 2011. British medical waste was mixed with general waste that was exported to Brazil for recycling.

In Saudi Arabia, one waste disposal company was fined SR20,000 (USD5,300) for dumping medical waste at a municipal landfill, and others have dumped it near a drinking water source.

As discussed above, about 180 tonnes of unsorted medical waste per day finds its way into the municipal garbage as a matter of routine in India alone. In fact this is probably the main disposal route in low to middle income countries.

It is also common for waste to be piled in the back yards of hospitals, sometimes in areas accessible to the public, or on streets awaiting collection by the municipal authorities. This

happens in Nepal, where dogs can be seen looking for pathological waste amongst the bags of waste. Amputated body parts have been reported as dumped in roadside bins in Bangladesh (Patwary *et al*. 2001c)

The problems do not end once waste has reached the dumps as these are the living and working environment of many people. This will be discussed further below, under the section on the right to safe working environments.

Waste Burning and Incineration

Burning and incineration of all types of waste also interferes with people's right to a healthy environment. Concerns around incineration often centre on the emission of persistent organic pollutants, particularly dioxins and furans. The atmospheric emissions from incinerators can travel globally. A 2005 report from the World Bank warned that if China built incinerators rapidly and did not limit their emissions, worldwide atmospheric levels of dioxin could double.

Burning and incineration of all types of waste also interferes with people's right to a healthy environment.

Cement kilns that burn hazardous waste as fuel and newer technologies for staged incineration (e.g. pyrolysis, plasma arc, and gasification) face similar pollution and health problems to medical waste incinerators, as they also create dioxins, furans and other toxic chemicals in the combustion process, which result in either air or ash emissions. In the European Union, staged combustion facilities are clearly defined as incinerators for regulatory purposes, although in some regions of the world they are being promoted as alternative "waste-to-energy" solutions.

Cement kiln incineration is potentially even more hazardous, as they usually lack the air pollution control devices necessary to deal with the sorts of emissions produced by waste. This technology is not recommended for medical waste processing under Stockholm Convention BAT/BEP guidelines.

The US regulations, the EU and the Stockholm Convention are all examples of tight regulation of the amount of pollution that is allowed to enter the atmosphere from incineration. Pollutants are instead captured in air pollution control devices (APCDs) and add to the quantity of incinerator ash, which needs to be treated as hazardous waste. A huge amount of research has been dedicated to this subject.

Less well known and investigated is the possibility of the release of viable bacteria. In 1989, Blenkharn and Oakland reported isolating *bacillus* spp., staphylococci including *Staphylococcus aureus* and pseudomonads from inside the stack (chimney) of a medical waste incinerator operating at 1000 degrees C. Bacteria were even cultured from one sample of ash. This means there is a very real possibility of viable pathogens being released from incinerators all over the world. *Staphylococcus aureus* is becoming increasingly resistant to antibiotics. These resistant strains are known as MRSA.

Figure 5. Waste burning in the grounds of a hospital in Nepal. This hospital has cleaned up its site since this photo was taken (Nakarmi/HECAF).

Figure 6. Chickens scratching in a hospital incinerator ash pit in Tanzania (Stringer/HCWH).

Regarding dioxins and furans, a modern incinerator, for example, in the EU, is expected to meet a dioxin emission limit of 0.1ng/m^3 toxic equivalents (TEQ). This standard has also been adopted by the Stockholm Convention (SSC 2008), which 173 countries have ratified to date.

These standards cannot be met in most of the world - including the developed world - and the burning or incineration of medical waste both creates and spreads pollution. Non-combustible materials such as mercury will be volatilised and literally hundreds of toxic products of combustion will be produced and distributed to the atmosphere and ash.

Incinerator ash is often buried or carelessly disposed of nearby. It will still contain blades, needles, broken glass and other sharps as well as toxic substances such as dioxins, furans, PAHs and heavy metals. It can be blown in the wind to spread contamination locally, and chickens can be seen scratching in ash pits. A survey of eggs near a small scale medical waste incinerator in India (IPEN 2005) found dioxins at 5 and a half times the EU limit for food.

Most low to middle income countries do not even have the facilities to measure dioxins and furans, but according to Batterman (2004), a well-designed and well operated small scale medical waste incinerator will emit approximately 10ng TEQ/m^3 in the exhaust gases. This is 100 times higher than the Stockholm Convention, and EU and US standards. However, the majority of small-scale incinerators will be substandard in some way. Improperly designed, constructed, maintained or operated units like this will emit up to 500ng TEQ/m^3; and if there is no afterburner, 4,000 ng TEQ/m^3 – that is, 40,000 times the emission limits agreed by the international community and ratified by 85% of the world's countries. This technology is clearly not acceptable in environmental terms.

China has a higher dioxin emission limit than most western countries (5ng/m^3) but even so, over half of the 147 incineration facilities have been identified as substandard and it has been decided that they should be dismantled. The possibility of using chemical, microwave and steam disinfection has now been opened up with the publication of technical specifications in 2005. Although implementation of non-incineration technologies is still at an early stage, researchers believe alternatives can become the main technical option (Yang *et al*. 2009).

Medical waste is often open burned in the premises of healthcare facilities, which is the most polluting practice. Small-scale incinerators, installed in thousands of healthcare facilities worldwide, are also environmentally very hazardous; WHO (2004) recommends that non-incineration waste treatment technologies be promoted to protect people from both the effects of unsafe healthcare waste management and exposure to dioxins and furans.

Figure 7. An Indian incinerator operator prepares to throw PVC medical waste into the incinerator, against the biomedical waste rules (Karliner/HCWH)

Small-scale incinerators have a poor performance record, with many breaking down within two years. In Tanzania, only 30-40% of the incinerators were in good operating condition, and half of them had serious problems such as missing chimneys, ash pits, covers for waste loading or ash removal doors.

Medical waste contains a high proportion of PVC, a chlorinated plastic which is used in blood bags, tubing and numerous other applications. The chlorine will contribute to the creation of polychlorinated dibenzo-p-dioxins and dibenzofurans. Also known as dioxins and furans, these are persistent organic pollutants which can last for decades or hundreds of years in the environment, build up in the food chain and pass from mother to chain. To ameliorate this, it is often recommended that PVC not be burned (see eg WHO 2004, MoEF India 1998), but in practice this is rarely enforced. PVC in medical waste can also be a major source of metals in the ash (Sabiha-Javied *et al.* 2008).

A study of dioxin emissions from a medical waste incinerator in India found it not only exceeded the 0.1 ng/m^3 limit almost 5-fold but emissions were higher than from a municipal and an industrial waste incinerator studied at the same time (Kumar *et al*. 2009). Other researchers found that the characteristic pattern of dioxin pollution from medical waste burning dominated air contamination near sites where it was incinerated in Delhi (Sanjay *et al*. 2009).

Small-scale incinerators also have a poor performance record, with many breaking down within two years. A survey of small healthcare centres in Dar es Salaam, Tanzania (Manyele & Lyasenga 2010), found that only 30-40% of the incinerators were in good operating conditions, and half of them had serious problems such as missing chimneys, ash pits, covers for waste loading or ash removal doors.

In Iran, 6 out of 9 private hospitals that had incinerators suffered operational problems (Askarian *et al*. 2004). In Bangladesh, researchers investigating the occupational health of waste workers did not find a single properly operating incinerator in the facilities in their study (Patwary *et al*. 2011b).

Figure 8. Burning does not destroy sharps, and they can still cause injury (Stringer/HCWH)

In the 1987, before the current generation of controls were imposed on medical waste incinerators, they were the second largest emitter of dioxin to the atmosphere in the USA, at 2,440 grams per year. By 1995, many medical waste incinerators had closed and the remainder had had much tighter controls imposed. Emissions had halved, but they still accounted for 17% of national emissions and ranked as the 4th largest source, behind garbage incineration, landfill fires and backyard burning (USEPA 2000).

Thus today, even without comprehensive data, it can confidently be predicted that medical waste burning is amongst the largest dioxin sources in developing countries and will remain to be so long as open burning and small-scale incineration are allowed to continue.

Mercury Pollution

Mercury from healthcare also pollutes the environment and endangers human health. Despite significant gains in several developed and developing countries, it is still widely used in many hospitals and health systems in elemental form in thermometers and sphygmomanometers.

Mercury thermometers and blood pressure devices add to the global burden of mercury removed from its below ground repository and spread about on the surface to form highly neurotoxic organomercury compounds. Further, these devices break or leak with regularity, exposing health care workers and patients to the acute effects of the inhalation of the metal itself. In view of this, health care providers and institutions have begun to replace mercury-based medical devices with affordable, accurate and safer alternatives, as part of a global initiative to reduce the use and spread of mercury in all aspects of society.

The health care sector is far from the greatest source of organic mercury compounds in the environment. Rather, coal-fired power plant emissions and mercury cell chlor-alkali plants, along with artisanal gold mining and battery disposal are all far more significant polluters. However, the health care sector does play an important role as a source of global emissions, and can serve as a leader in efforts to phase out mercury in daily commerce.

Mercury can be found in many health care devices and is present in fluorescent bulbs as well as dental amalgams. Mercury is also found in many chemicals and measurement devices used in health care laboratories (HCWH 2007). Medical waste incinerators, as well as municipal waste incinerators, emit mercury into the atmosphere when they burn wastes that contain mercury. According to the U.S. Environmental Protection Agency (EPA), in 1996, prior to the mercury phase-out in U.S.

health care, medical waste incinerators were the fourth largest source of mercury emissions to the environment. Hospitals were also known to contribute 4-5% of the total wastewater mercury load. Mercury fever thermometers alone contributed about 15 metric tons of mercury to solid waste landfills annually (USEPA 1996).

While no comprehensive figures are available, anecdotal evidence suggests that in most of Asia, Africa and Latin America, mercury spills are not properly cleaned, nor is the waste segregated and managed properly. Rather, it is incinerated, flushed down the drain, or sent, via solid waste, to a landfill.

Thermometer breakages on a case-by-case basis pose some harm to patients, nurses and other health care providers when mercury is absorbed through the skin or mercury vapour is inhaled. Only a relatively small amount of mercury – roughly one gram[1] is released when each thermometer breaks. However, when taken cumulatively on a hospital ward, in an entire hospital, nationally and globally, the situation takes on more serious dimensions.

In Buenos Aires, for instance, the city government, which runs 33 hospitals and more than 38 clinics, was purchasing nearly 40,000 new thermometers a year, until it began to switch over to alternatives in 2006 (Grebnicoff 2006). Given that nurses and other health care professionals often buy their own thermometers to supplement the city's procurement, the city's health system was using well over 40,000 thermometers a year, most of which would break, and some of which would be taken home (where most would ultimately break as well). The system was ultimately emitting in excess of 40 kilograms of mercury into the local hospital environment and into the global ecosystem every year.

If one were to use this figure and extrapolate for the entire country, one can estimate that until recently thermometers broken in Argentina's health care system were spilling 826 kilos, or nearly 1 metric ton of mercury, into the global environment every year.

In Mexico City, the 250-bed "Federico Gomez" Children's Hospital is a medical service, teaching, and research hospital affiliated with the National Autonomous University of Mexico. This prestigious children's hospital documented a thermometer breakage rate of 385 per month, or well over 4,000 per year. The total number of estimated broken thermometers in this one hospital between 2002 and early 2007 is nearly 22,000 - the equivalent of 22 kilograms of mercury (HCWH/CAATA 2007a).

Thermometer breakages on a case-by-case basis pose some harm to patients, nurses and other health care providers when mercury is absorbed through the skin or mercury vapour is inhaled.

While the Federico Gomez hospital has substituted its mercury devices with alternatives, when it undertook its initial assessment there was no clean-up protocol for mercury spills. Rather, mercury waste was deposited with both infectious and biological hazardous wastes, or with municipal wastes. Broken fluorescent lamps were also treated as municipal waste. Mercury containing equipment was not repaired if broken, and the procedure followed was to merely register the loss and replace it with new equipment (HCWH/CAATA 2007b).

The regular and ongoing breakage of thermometers and the lack of mercury waste management protocols and practices found at the Federico Gomez hospital is not an

[1] Mercury mass in thermometers may vary from 0.5 to 1 g / thermometer. For the purposes of this article we will use the widely reported estimate of 1g/ thermometer.

exception, but more generally the rule in hospitals throughout much of the Global South, where patients and health care workers are regularly and unknowingly exposed to this toxin.

While sphygmomanometers break less frequently than thermometers, the spillage is significant and therefore problematic from an environmental health perspective. At the Mayo Clinic in the U.S., between 1993 and 1995, 50 incidents were documented relating to leakage and spills from sphygmomanometers (HCWH 2003).

Pharmaceutical Wastes

Under normal circumstances, chemical and pharmaceutical wastes constitute less than 3% of medical waste. However, the potential for harm from improperly disposed of pharmaceutical waste is significant. Many pharmaceuticals are consumed in the home and few countries have proper collection systems. In Turkey, for example, a survey found that more than half of those interviewed did not bother to complete the course of treatment, and 95% threw the unused pharmaceuticals into the municipal waste (Uysal & Tinmaz 2004). Like other wastes, pharmaceuticals can be scavenged for resale by or to unscrupulous operators, and drug addicts may also attempt to use/misuse them (Appleton & Ali 2000, Patwary *et al*. 2011a).

The problem of waste pharmaceuticals can reach extreme proportions in certain situations. In the wake of the 2004 Indian Ocean tsunami, huge amounts of unsolicited pharmaceuticals were donated. In January 2006, the amount was estimated at anywhere between several hundred and 6000 tonnes. Many of these donations were not on the list of essential drugs, labelled in the wrong languages, or had unacceptably short expiry dates. A few hundred tonnes are reported to have been collected and sent for burning in cement kilns (WHO & FAO 2006) but that accounts for a small fraction of the total and there were also anecdotal reports of open burning where this was not possible.

WHO has issued guidelines on the donations of pharmaceuticals (WHO 1999); if these were adhered to, it would reduce this problem significantly. Other waste reduction measures include: providing only the required amount of pharmaceutical (as opposed to entire packets); selecting the most environmentally benign substance where there is a choice of treatments (see SCC 2009); and prescribing pills instead of injections to reduce the amount of sharps waste.

Many pharmaceuticals are consumed in the home and few countries have proper collection systems. Like other wastes, pharmaceuticals can be scavenged for resale by or to unscrupulous operators.

Once all the options to reduce the amounts and harmfulness of pharmaceutical waste have been exercised, the best disposal option, recommended by WHO amongst others, is for the manufacturer to take back the waste pharmaceuticals. Knowing their chemistry, they could either dispose of them properly or, preferably, extract, purify and reuse active ingredients. Pharmaceuticals collected by manufacturers via “reverse distribution” may be

classified as products rather than wastes, and therefore subject to different sets of legislation (Vallini & Townend 2010).

Pharmaceutical wastes are complex and hard to deal with. Non-incineration technologies to dispose of them have not been able to penetrate a market where legislation tends to insist that they be incinerated. There are specific chemical reactions to deactivate some pharmaceuticals but by no means all. One of the most commonly cited pharmaceutical deactivation agents is sodium hydroxide. High temperature reaction with sodium hydroxide is currently used to digest tissues, and these machines could plausibly destroy pharmaceuticals and other toxic chemicals. However, if the technology is excluded from the market by legislation, manufacturers cannot justify the investment in testing its efficacy on the many drugs and other chemicals in use in the medical industry today.

If it is not possible to return pharmaceuticals to the supplier, one option for low income countries is to encapsulate or inertise them, then landfill. Encapsulation involves sealing the wastes in a metal or plastic drum full of cement or similar material, whereas inertisation means removing the pharmaceuticals from their packaging, grinding and mixing with a mixture of water, cement and lime (see WHO 1999 for more details).

As discussed above, low to middle income countries have limited incineration capabilities. As a result pharmaceutical wastes are either dealt with as the rest of the waste, or may be sent to cement kilns for burning. These are often regarded as the best option to dispose of pharmaceutical waste in low to middle income countries, but they do not have the complex air pollution devices needed to keep dioxin emissions to the levels expected in the developed world. The blister packs that pills are usually packed in are made out of PVC, which will increase dioxin creation.

Wastewaters from healthcare facilities are often neglected, but they may also carry a significant burden of pathogens, chemicals and pharmaceuticals- the latter excreted by patients- into the environment.

Conventional sewage treatment cannot destroy industrial chemicals and they are commonly found either in the effluent or sewage sludge (Rahman *et al*. 2008, Stringer & Johnston 2001).

Because they are designed to exert a biological effect, pharmaceuticals can be expected to have a strong impact on aquatic ecosystems. Many are environmentally persistent and even those that are not will have a persistent effect if they are discharged on a daily basis from hospitals (Bengtsson *et al.* 2006).

Pathogens

Healthcare facility effluents have high levels of drug and antibiotic resistant bacteria. These can transfer the genes that confer resistance to other bacteria they come into contact with. In Portugal, researchers tested sewage samples upstream and downstream of hospitals, and in the river system that the sewage enters. Several types of resistant bacteria were found in greater concentrations downstream of the hospitals than upstream.

Vancomycin resistant enterococci (VRE), which is of concern because the infections it causes are very hard to treat, was not found at all upstream of the hospitals, either in sewers or rivers. However, it was present in 11/14 sewage samples downstream of the hospitals

and 2/3 samples from the river estuary. The researchers concluded that reducing the release of bacteria and genetic elements from the healthcare sector is essential to prevent the environment becoming a reservoir of antibiotic resistance (Novais *et al.* 2010).

Low to middle income countries often do not have proper municipal wastewater treatment systems and require hospitals to have their own. A long way remains to go before this is completed. For example, the *Viet Nam News* reported that only 52 of the 113 hospitals in Hoi Chi Min City had wastewater treatment systems. Another 7200 private clinics have basic systems such as septic tanks. The Department of Health wants to make it mandatory for hospitals to have water treatment systems, and resources for improving this and other aspects of medical waste management.

Healthcare facility effluents have high levels of drug and antibiotic resistant bacteria. These can transfer the genes that confer resistance to other bacteria they come into contact with.

The Right to a Safe Working Environment

Improper medical waste treatment prevents an untold number of people from enjoying their right to a safe working environment.

In some cases, the waste disposal is so poor that is affects the entire community around it. In February 2011, the Pune Mirror in India described filthy conditions at the Aundh General Hospital, with waste scattered around the hospital grounds, and clogged drains. Animals including goats, cows, pigs and dogs roamed the site. The report blamed the high levels of dengue and chikungunya in the staff on the mosquitoes that bred in the pools of stagnant water. Family members living in the staff quarters and others living nearby will also be at risk.

Both staff and patients at Gulu Hospital in Uganda also complained that the garbage in the grounds, saying that is caused nausea and affected their health.

Medical waste should be segregated at source, and transported and handled in a way that prevents anyone coming into contact with it- either through the type of containment, or the use of protective clothing and equipment. Measures should be taken to avoid needle-stick injuries, and offered post exposure prophylaxis should they suffer one. Medical staff and all waste handlers that form part of the local management system should be vaccinated against common infectious such as tetanus and hepatitis. All bins and equipment should be kept clean. Untreated waste should never be segregated, but treated according to its hazardous constituents. Hazardous chemicals and products such as mercury-based medical devices should be substituted for safe, affordable, accurate alternatives.

In too many cases, however, these basic rules are ignored and people are forced to work in unsafe conditions. A range of occupations are affected - from medical staff and hospital cleaners, to waste handlers and disposers within the hospital and to municipal waste transport workers and informal sector recyclers who work at transfer stations and dumpsites. The pictures below are drawn from a number of different sources and show scenes which are repeated around the world.

Medical staff

The first people to come into contact with medical waste are its creators, primarily medical staff, but also laboratory workers and pharmacists and others. The greatest number will be nurses, who make up a far larger part of the workforce than doctors and do the majority of the day-to-day caring for the sick.

An unpublished survey by the Nepalese NGO HECAF found that 11% of the needle-stick injuries suffered by nurses in the city of Pokhara occurred while they were disposing of waste.

Mercury waste from thermometers or other medical devices can contaminate the air and pose a threat to workers' health. In a study of New Delhi hospitals, the NGO Toxics Link found dangerously high levels of mercury in a series of indoor air samples. They found the "substantial presence of mercury in ambient air of both the hospitals" studied. These levels, which ranged from 1.12 microgram/$m^3$to 3.78 microgram/m^3, were all higher than numerous international standards (Pastore *et al*. 2007).

One of the biggest mercury hot spots that Toxics Link found in its study was the room

used to calibrate blood pressure devices (sphygmomanometers), which contain 80-110 grams of mercury or roughly 100 times the amount found in a single fever thermometer.

Mercury release and contamination from sphygmomanometer calibration is a common problem throughout the world. Louis Havinga, Manager of Health Technology Services for the KwaZulu Natal Province Department of Health in South Africa explained:

"*This is the most important point why the Health Technology Services has moved away from the use of mercury products. The technicians were exposed to mercury when they repaired mercury column sphygmomanometers. Special precautions and equipment is needed if working with mercury products like a dedicated fume/vapour extraction unit within the maintenance department. The mercury is extracted from the device and placed in a special marked container. The container must be able to seal and should remain inside the fume/vapour extraction unit. Once the container is full, the container must be disposed of in a well documented and controlled manner by making use of a recognized hazardous waste disposal company which is very costly*" (Pers. Comm 2007).

Figure 9. Old plastic bottles make acceptable sharps containers, but they need to be replaced when they are 3/4 full (Stringer/HCWH)

Figure 10. Filthy and blood-spattered bins like this are far too common a sight (Stringer/HCWH)

Cleaners and In-hospital Waste Treatment Staff

The staff who clean the hospital and collect the waste may often be at greater risk than medical staff who produce it. Whereas a medical practitioners' dealing with waste is over once they have placed it in the bin, cleaners may have to handle it extensively. They are usually poorly educated and trained and little attention is paid to their comfort and safety. It is uncommon for them to have vaccinations or proper protective equipment. Disposable latex gloves may be provided, but they are thin and offer little protection. In warmer climates, the majority of cleaners will only wear sandals.

In addition they may be employed by contractors to the hospital rather than being directly employed by the hospital, and as a consequence may not be afforded the same

level of job security, training or access to vaccination as other hospital staff.

73% of waste workers interviewed in Dhaka, Bangladesh were not provided with adequate personal protective equipment (PPE). Only 18% of them wore PPE regularly, and some reported only doing so during when external dignitaries made official visits. Almost all (94%) of them reported having experienced an injury in the previous month. Of these, 28% were regarded as serious by the workers, on the basis of the symptoms they reported (Patwary *et al*. 2011b&c). A large proportion of the injuries were to the feet, through stepping on sharps, or sharps or chemical injuries to the hands. Many of these would have been prevented by proper PPE).

Figure 11. Waste of all types in a hospital yard, awaiting the waste contractor (Stringer/HCWH).

As well as the physical injuries (cuts and stabs from sharps, falls down stairs), the workers also reported emotional responses ("*irritability due to seeing horrifying waste"*) and physical symptoms (dizziness, headaches, acidity and vomiting) (Patwary *et al*. 2011b).

Workers had a very fatalistic attitude to accidental injuries, often regarding it as an aspect of their work that simply had to be accepted. Unfortunately, this attitude was mirrored by their managers, many of whom did not see it as their responsibility to ensure that their workers were protected. One typical quote from a manager was: "*This is related only to the fate of that person that has had an accident. It is not our duty to take action against their fate."* (Patwary *et al*. 2011b).

Figure 12. Carrying waste in bags, by hand, risks spills and injuries from protruding sharps (La Prensa, Honduras).

Iranian researchers found that there was no training on medical waste handling or the associated hazards in a sample of 15 private hospitals (Askarian *et al*. 2004).

Sawalem *et al*. (2008) also found inadequate levels of training in Libyan hospitals. Only four of the 14 hospitals they investigated used proper PPE, and none at all was used in five.

In Tripoli, a survey of 300 medical waste handlers, working for a local contractor, found that only 7% had received training in waste handling, and 21% were immunised against hepatitis B. Although almost all wore overalls (presumably the company uniform) when working, only 57.7% wore gloves, 55% boots and only 17% masks when handling medical waste. Their health had demonstrably been harmed as a result as they had significantly higher levels of hepatitis than waste handlers

who had no contact with medical waste (Franka *et al*. 2009).

95% of waste workers in Dhaka Bangladesh had a very fatalistic attitude to accidental injuries, often regarding it as an aspect of their work that simply had to be accepted. Unfortunately, this attitude was mirrored by their managers, many of whom did not see it as their responsibility to ensure that their workers were protected.

According to Ataf and Mujeeb (2002, 2003) hospital workers have high levels of hepatitis B, with medical centre sweepers having the highest levels: 20%. Laboratory workers were also at risk, with staff in only 4.5% using gloves. 12% used protective gowns and 18% used needle cutters, though 64% of labs did have needle cutters, so the problem can be attributed to bad practice as well as lack of equipment.

Figure 13. Hospital waste worker in Nepal (Stringer/HCWH)

Pathological waste, including test-tube or slides that have been used to test blood, or bacterial cultures, are among the most dangerous infectious wastes and should be disinfected by autoclaving before further handling of any kind. However, in low and middle income countries, this tends not to happen, because the resources to purchase or maintain a dedicated autoclave are not available. However, the need to save money drives these same facilities to reuse materials, so cleaning staff often wash products such as test tubes and slides that contain blood. This places them at risk of cuts from broken glassware and exposure to blood-borne and other, highly concentrated pathogens.

Figure 14. A Delhi hospital worker separates syringes into different plastics before shredding and selling (Stringer/HCWH)

Waste should be transported in sealed trolleys for staff safety reasons. However, it is very common to see waste being transported by hand in bin bags, risking spills of toxic or

infectious liquids, or staff injuries from protruding needles or other sharp objects. In 70% of small facilities in one part of Dar es Salaam, Tanzania, waste was carried by hand. Wheelbarrows were used in 40% of facilities in another part of the city.

Figure 15. A non-functional incinerator is used as a site to burn highly infectious waste (Stringer/HCWH)

Waste will usually be stored onsite, at least for a few hours before collection for offsite treatment/disposal. Too often this is occurs in such a way as to create unhealthy working environment for all the medical staff.

It is not uncommon for hospitals to economise on waste treatment costs by dumping it onsite. This creates a worse hazard than the temporary storage as the waste decomposes and creates extremely unhealthy conditions. Flies, rats and other vermin and disease vectors will also be attracted to the site.

Some hospitals will also treat their waste in-house. This can be done safely but examples of bad practice abound.

In India, the biomedical waste rules (1998) specify that plastics are cut to prevent reuse and then put into a bleach solution to disinfect it. However this may be ineffective if it is not fresh and properly diluted. Waste treatment staff who separate them into different plastics for recycling may be vulnerable to infections and injuries from uncut syringe needles.

Many hospitals will have small-scale incinerators. Again, the operators are unlikely to have proper training and clothing. They are at risk of burns, injuries and impacts from waste, and inhalation of the ash. Figure 3 shows a typical scene; the operative is wearing only sandals. BaliFokus, and Indonesian NGO, report workers handling incinerator ashes without protective clothing (see Indonesia country snapshot).

Municipal Waste Workers

With so much waste going in to the municipal system, there are additional hazards for garbage collectors and other waste disposal workers.

In the developing world, these workers most often have little or no protective equipment or health and safety support at work. *Waste Management World*, the journal of the International Solid Waste Association (ISWA)(Anon 2011) described the situation in one part of Andhra Pradesh State. Most “Field level sanitation jobs” are now outsourced, and are not given shoes, masks or gloves to wear

at work. They reportedly complain of frequent health problems, but the health authorities do not keep records.

Figure 16. A council subcontractor collecting waste from a hospital in Tanzania wearing only sandals. (Stringer/HCWH)

Thompson *et al*. (2010) published a small survey of Mexican sanitation workers conducted in 2003. The 69 individuals interviewed reported total of 22 needle-stick injuries in the previous year. The median number of injuries was 1, the maximum was 5. Over half had seen syringes or needles in the preceding week, but only 11% always wore gloves at work and only 4% had been vaccinated against hepatitis B. In *La Prensa* in Nicaragua, a municipal worker reported being injured by needles and other sharps on several occasions, despite wearing leather gloves all the time. He had been vaccinated against tetanus, but was worried that he was not protected against the other diseases that could be contracted from medical waste.

The pictures show similar situations in other countries (Tanzania and Bangladesh). The Tanzanian workers were reportedly subcontracted to the council. The baskets beside the Bangladeshi worker contain a small amount of infusion sets, vials and other medical waste he has sifted out to sell. This is all that is left by the time the waste reaches his station at the back of the hospital. He and others like him are also likely to encounter pathological waste; Bangladeshi hospitals often dispose of unsegregated medical waste of all types, including body parts, to the municipal system (Hassan *et al*. 2008).

Figure 17. Bangladeshi municipal worker in a hospital. The baskets contain medical devices (eg vials, infusion sets) he has segregated to sell, either for scrap or illegal reuse. (Stringer/HCWH)

Rag Pickers

Since much medical waste has a value as recycling feedstock, hospital staff also often sell waste direct to waste merchants in order to supplement their incomes. This is an understandable practice, especially where the hospital has no recycling program and since some of the materials, such as aluminium from vial caps or plastic containers for saline or dialysis fluid may not be infectious and can be used as a feedstock for recycling into other products, it does not always cause harm. However, other materials, such as blood bags or syringes, are extremely hazardous and the practice puts at risk whoever handles it. *The Daily* Star in Bangladesh and scientific researchers (Hassan *et al*. 2008, Patwary *et al*. 2011a,c) have documented the sale of the majority of waste, including non-hazardous paper and packaging but also syringes and needles, by hospital cleaning staff.

Many of the ragpickers in Pakistan are Afghan refugees. They frequently suffer infections from medical waste and also suffer violations of their most fundamental rights. Some children may be held in servitude at the dumps or forced to wrok in the sex industry.

Medical waste is also sought out by ragpickers, some of society's most neglected members, who put themselves at great risk collecting it.

Rag pickers are often seen in hospital grounds; it may be an important part of their territory. Nepali environmentalists tell the story of one Nepali boy who comes to a hospital at 3pm every day to collect waste. This allows him to buy medication for his sick mother and eat in the evening.

Others may collect medical waste from dumpsters, on the streets, or at landfills. In Bangladesh, ragpickers and those involved in the informal medical waste recycling industry reported a range of symptoms which may have been a result of contact with waste, including headaches, dizziness, heaviness of head, fatigue, difficulty concentrating and tiredness. One individual had sores on his hands on feet that he described as having started as blisters "*with a lot of itching and pain"* after a puncture injury some months previously (Patwary *et al*. 2011a). It is true that many of the ragpickers were drug users, their symptoms are similar to those reported by recycling workers and hospital waste workers (Patwary *et al*. 2011a&b), who were less likely to be drug addicts.

Figure 18. Ragpicker in Kathmandu (Nakarmi/HECAF)

Figure 19. Medical waste at a city dump in Tanzania (Stringer/HCWH)

Press reports in China have raised the alarm about medical plastics, some of it picked from dumps by ragpickers, being recycled into food contact materials. Uysal and Timnaz (2004) report that medical waste in Turkey is typically disposed of with municipal waste and poses a threat to ragpickers. Similarly, Honduran newspapers reported with concern the mixture of medical waste at the dumps.

A 2010 report in *Afghanistan Today* indicates that many of the ragpickers in Pakistan are Afghan refugees. They frequently suffer infections from medical waste and also suffer violations of their most fundamental rights; some children are kept in servitude by gangmasters at the dumps and their parents paid 6-8 Euros for 2 weeks of work. They are not fed and depend on charities and aid agencies, or eat what they can find at the dumps. They may also be sexually abused or forced to work in the sex industry. Social workers say that because they are the children of illegal immigrants, they have no legal protection in Pakistan.

Even in places such as Africa, where there is less of a recycling industry and the lack of a market for medical waste means that it is generally avoided by ragpickers, mixing medical waste with ordinary garbage makes an already tough and unpleasant occupation even more dangerous.

Waste Recyclers

Waste recycling is an important part of the modern product cycle and as much as 90% of modern municipal refuse can be recycled, composted, or turned into biogas through anaerobic digestion processes. However, when medical waste enters the mix, it can make the municipal recycling facility a hazardous place. In South Africa in May 2010, a municipal recycling centre was shut down by the authorities after two incidents of medical waste being found in two of the black bags- the colour typically used for ordinary garbage- that were sent to them to process.

The working environment of those whose full-time occupation is treating waste can be unacceptably hazardous if they do not have the requisite equipment, training, and vaccination.

Informal recyclers are also common in many parts of the world. Informal recycling facilities can be extremely hazardous places with multiple chemical and physical hazards. These hazards are compounded when they use untreated medical waste as a feedstock.

Pakistani researchers (Altaf & Mujeeb 2002, Mujeeb *et al*. 2003) identified plastics recyclers who processed untreated waste; the majority of it was granulated and made into other products, but some syringes were washed and packaged for resale.

Figure 20. A woman sort syringes at a recycling centre in South India (Hodges/University of Warwick)

In India, waste that is destined for the Common Treatment Facilities (CTFs) which are charged with treating waste, often ends up at recyclers instead. Amongst the many examples found in the Indian press, the Jammu and Kashmir state pollution control board seized the driver from a local CTF in the process of unloading untreated medical waste from the CTF vehicle at a scrap dealer's shop. In Bangladesh, the following were reported as being resold: glass bottles, syringes, tubing, discarded/expired medicines syringes, saline bags, tubing, glass bottles, medicines, knives and blades (Patwary *et al*. 2011a&c). General waste that has been mixed with medical waste is also likely to have picked up pathogens or hazardous materials from the medical waste and will put any waste collector or recycler who handles it at risk.

Selling of waste has been reported in the press in Bangladesh, including syringes which are washed, repackaged and resold, without proper sterilisation. Weak enforcement of existing laws is blamed as contributing to the problem, for example, by a member of the Bangladeshi NGO PRISM, who run a waste treatment centre in the capital, Dhaka. He notes that the Department of Environment (DoE) should certificate the waste disposal system of a healthcare facility before it can start operating. The DoE said that they lacked manpower, but were recruiting more inspectors.

In Nepal, local NGO HECAF explain that sharps containers may be stolen from hospitals- particularly emergency wards. These presumably feed into the recycling business, possibly the more lucrative syringe repackaging. The plastic from disabled and disinfected syringes in Nepal has a value of 20 Nepalese Rupees (NPR)(US 25 cents) per kilo; repackaged syringes can sell for 5 or 6 NPR (US 7 or 8 cents) each.

Environmental NGO BaliFokus also report that workers sell waste in Indonesia and HCWH SEA have observed the same in the Philippines.

Waste that is destined for the Common Treatment Facilities which are charged with treating waste, often ends up at recyclers instead. The following were reported as being resold: glass bottles, syringes, tubing, discarded/expired medicines syringes, saline bags, tubing, glass bottles, medicines, knives and blades.

India, with around 160 or 170 common treatment facilities, and an active press corps, but an imperfect enforcement regime, provides some good examples of the problems that can occur:

In Mumbai, India in 2010, police intercepted waste including surgical gloves, syringes, needles, catheters and other medical paraphernalia, which they believe would be reprocessed and sold back to hospitals.

In Jammu and Kashmir, India, 2010, police intercepted a van of waste including used

syringes, bandages, drip-sets and surgical gloves. The wastes had been collected from various hospitals by a common treatment facility but rather than being disposed of properly, they were being sold to a scrap dealer.

Untreated medical waste can reach the recycling industry by a number of routes. It can come from ragpickers, as described above. It can be also be sold directly by the staff. This is extremely common. Some of the waste may not be hazardous (empty water bottles, cardboard, aluminium from vials), but other material - syringes, blood bags, laboratory waste - could prove extremely dangerous. In Bangladesh, scavengers were observed to pay waste truck drivers to wait while they took what medical waste they wanted. Rag pickers, often intravenous drug addicts, collect used syringes and scavenged drugs either for their own use, or sell them to others like themselves, to drug dealers, or even directly to pharmacies (Patwary *et al*. 2011a).

In India, Nationally, approximately 10% of Indian healthcare facilities admitted to selling syringes (ICLEN 2004).

Radioactive materials can also end up as scrap. In 2010, equipment from Delhi University ended up at a scrap yard, causing radiation sickness in 7 people and one death (AERB 2010). Whereas this incident did not involve medical equipment, it gives an indication of the dangers that this sort of equipment holds for recycling workers. An Op-Ed in *The Hindu* newspaper described around 10 occasions on which radioactive sources were lost or stolen. One, in 2002, involved a radiography camera. The article states "*There have been instances year after year of loss and theft of sources from installations, particularly industrial sites. Most of these incidents, however, are not due to the inadequacy of the AERB's regulatory system but due to non-compliance and laxity on the part of the end-users*".

Workers in Centralised Medical Waste Treatment Facilities

Where they are enforced, high operational standards can protect workers from harm. At a specialist waste handler in the UK, workers averaged one needle-stick injury for every 29,000 hours of work, and there were no seroconversions. Improper disposal such as sharps in bin bags did still occur and good PPE (eg ballistic gloves) helped workers. The need to maintain standards to protect staff was stressed (Blenkharn & Odd 2008).

Mercury entering the medical waste stream through use and improper disposal of broken thermometers, blood pressure meters or batteries can contaminate the working environment of centralised treatment facilities.

Indoor air is cited as the second largest contributor to mercury concentrations in the general population, after fish consumption. It was found at high concentrations in gaseous and particulate form in a hospital waste incinerator in China. Concentrations were higher than in a municipal waste incinerator. In the hospital waste depot, the total mercury concentration was over 3000 ng/m^3 compared with a typical ambient concentration of 10ng/m3. It was below the OSHA limit for occupational safety, but vapour levels were well above the ATSDR minimum risk level for mercury vapours (200ng/m^3 or 0.2micrograms/m^3) (Liu *et al.* 2008).

The Right to Life and Health

As discussed above, the direct and quantifiable evidence of the harm done by the mishandling of medical waste is extremely limited. No data could be found on harm done to medical staff, waste workers or the public as a direct result of the improper disposal of chemical or radioactive waste.

However, even if the numbers of people whose rights to life and health are compromised by these types of waste cannot be calculated, exposure scenarios and potential for harm are obvious.

Chemical Exposure

The dioxins and furans are a group of pollutants created by burning and incinerating medical waste. Burning and incineration of medical waste is a significant contributor to global dioxin contamination.

Workers in medical waste incinerators or anyone handling the ash without proper protection will be particularly highly exposed. It can also be taken up into the food chain, and the contamination of eggs close to a medical waste incinerator was discussed earlier.

Because of the complexity of understanding all 210 dioxins and furans, most experimental research is carried out on one dioxin, 2,3,7,8-TCDD. This is classified as a known human carcinogen by the International Agency for Research on Cancer (IARC) and also causes immunological, endocrine, reproductive and developmental effects. Children and the unborn are the most vulnerable to their effects.

As discussed earlier, incinerators emit toxic metals, dioxins and furans and other organic pollutants. The effects of these contaminants can be subtle, and incinerators are often sited in places which suffer other pollution problems, so they add to a general pollution stress on the population and precise cause and effect of the individual chemicals is blurred. Despite this, the most comprehensive reviews of the effects of incineration find multiple epidemiological studies and other evidence for the health effects occurring in the general public (Thompson & Anthony 2008, Allsopp *et al*. 2001).

If mercury is spilled on the ward, for example from a broken thermometer, it can slowly volatilise. Mercury causes a variety of significant adverse impacts on human health and the global environment. High levels of metallic mercury vapour may produce pneumonitis and pulmonary oedema if inhaled, and though skin absorption is fifty-fold less than lung absorption, toxic levels have been reported due to handling of the liquid metal. This exposure is especially significant if the epithelial barrier has been broken due to cuts or abrasions. Target organs other than the lungs include kidneys, nervous system and gastrointestinal tract. Anecdotal reports from hospitals using mercury thermometers report breakage rates ranging from several to several hundred a month. These reports are paralleled by those noting leakages of mercury-containing sphygmomanometers, where there is potential for the release of significantly larger amounts from each incident.

Yet, of even more concern is potential for developmental neurotoxicity produced by low dose methyl mercury exposure through food.

Elemental mercury accumulates in lake, river, stream, and ocean sediments, where it is transformed into methyl mercury, which then accumulates in fish tissue. This contamination of fish stock is ubiquitously present in oceans and lakes throughout the world, concentrating several hundred thousand times as it moves up the aquatic food chain.

Methyl mercury is of special concern for foetuses, infants, and children because it impairs neurological development. When a woman eats seafood that contains mercury, it accumulates in her body, requiring months to excrete. If she becomes pregnant within this time, her foetus is exposed to methyl mercury in the womb, which can adversely affect the foetus' central nervous system. Impacts on cognitive thinking, memory, attention, language, and fine motor and visual spatial skills have been documented in children with exposure in utero to levels of methyl mercury found in women of child bearing age in the US (USEPA 2010).

The United Nations Environment Programme (UNEP) and World Health Organization have identified the adverse effects of mercury pollution as a serious global environmental and human health problem (UNEP 2002). The UNEP Governing Council has targeted reducing methyl mercury accumulation in the global environment as a major global priority (UNEP 2007).

Other toxic constituents of medical wastes include pharmaceuticals and disinfectants, including silver. Radioactive materials can cause burns, cancer, death, and intergenerational effects.

Infections

It has been estimated that the chances of infection after a needle-stick injury from a contaminated syringe is 0.3% for HIV, 1.8% for hepatitis C but 30% for hepatitis B (Batterman 2004).

A 2010 meta-analysis commissioned by WHO (Reid 2010) found that in 2008, 14% of HIV (342,000 cases), 25% of Hepatitis B (15 million cases) and 8% of hepatitis C (1 million cases) are attributed to unsafe injections, as well as 3 million cases of bacteraemia and 850,000 abcesses. There is no breakdown that allows for the estimation of the proportion that happen due to unsafe medical waste management.

It is also possible to contract a disease from exposure to general infectious waste, general waste that has been mixed with infectious or hazardous healthcare waste; or through human or animal vectors. Each person or animal directly infected can infect others.

Antibiotic resistant bacteria pose an enormous risk to global public health. Bacteria with a resistance gene called NDM-1 have recently emerged from India and Pakistan and been detected in 13 countries in Europe, the Middle East, North America, Asia, Australasia and Africa. This gene has been associated with hospitals. Of 25 patients identified in the UK, 17 had been to India or Pakistan in the previous 12 months and 14 had been in hospital there.

Researchers describe the risk of NDM-1 bacteria spreading as alarming because "*multidrugresistant bacteria (increasingly familiar even to the lay public as 'superbugs') could disseminate worldwide very quickly and originate a wide and uncontrollable spread of pandemic clones for which new and effective antibiotics are currently not available*" (Rolain *et al*. 2010).

Figure 21. A crow eats a human placenta. The potential for inter-species disease transfer by this route has not been investigated (Stringer/HCWH)

Figure 22. Elephants in Botswana rummage through a dump containing medical waste. They are known to be susceptible to human tuberculosis (courtesy J. Emmanuel)

The potential for diseases to travel between humans and other species is well known. The UK Health and Safety Executive state that there are approximately 40 diseases in the UK that can transfer from animals to humans. Salmonella and influenza (avian flu and H1N1) are amongst the best known zoonoses, and HIV is derived from a similar virus in primates - probably chimpanzees.

Approximately 75% of emerging diseases are thought to be zoonoses. Chomel *et al*. (2007) give the leading causes of their emergence as "*human behavior and modifications to natural habitats (expansion of human populations and their encroachment on wildlife habitat), changes in agricultural practices, and globalization of trade. However, other factors include wildlife trade and translocation, live animal and bushmeat markets, consumption of exotic foods, development of ecotourism, access to petting zoos, and ownership of exotic pets*".

However, the possible role of improper disposal of medical waste in spreading human diseases to animals, with the possibility of their being retransmitted to humans either in the same or modified form has not been studied.

Tuberculosis can affect many species including primates, cattle, and birds. The bovine form can be transmitted to and caught from wildlife. Bovine TB can also infect humans, particularly in developing countries, where it may be responsible for up to 10% of cases. Human TB was found in zoo animals in Los Angeles between 1997 and 2002 and though no active cases were found in zoo staff, 55 showed positive skin tests, and could have caught the infection from the animals (Oh *et al*. 2002).

A South African newspaper report in 2004 relayed the suspicion that the TB in a troop of baboons which scavenged from an uncontrolled landfill had been caught from medical waste being dumped there.

MRSA (methicillin resistant *Staphylococcus aureus*) is known to the public as a "superbug", a hard to treat bacteria that has traditionally been associated with hospitals, where it infects wounds and often kills people with weakened immune systems. However, MRSA is now found in many other environments. In 2011, it has been reported in bedbugs (along with another antibiotic-resistant bacterium) for the first time and a new strain has been identified in cows and dairy workers in the UK.

Animals are often seen scavenging amongst medical wastes: rats, dogs, cats, goats, birds (chickens, crows, buzzards and marabou storks), pigs, cattle and even elephants. The extent to which they can spread has not been investigated.

Bedbugs have not been demonstrated to pass disease to humans and the source of the MRSA in the cattle is thought to have been overuse of antibiotics. Nor is transmission of MRSA via milk thought to be likely, as it is killed by pasteurisation. However, in countries where cattle rummage through medical waste, they clearly could become infected with hospital-derived MRSA and pass it on to people who are in direct contact with them.

Bedbugs have been increasing worldwide and the possibility that they could spread infections should be taken seriously. The bedbugs in which MRSA was found had come from people treated at a particular Vancouver hospital, and resident in a poor part of that city, where both MRSA and bedbugs have become more prevalent in recent years.

Other animals are often seen scavenging amongst medical wastes: rats, dogs, cats, goats, birds (chickens, crows, buzzards and marabou storks), pigs, cattle and even elephants. The extent to which they contract tuberculosis, MRSA or other diseases as a result is completely unquantified, as is the chance that they will act as a route of human disease. However, the potential for infection in both directions is clear.

General Population

The general population can be affected when they enter the healthcare system as patients. In low income countries, patients may be asked provide their own syringes, a policy designed to reduce the cost of providing patient-care. However, as discussed above, unscrupulous recyclers can repackage used syringes for resale. These often end up in small pharmacies where members of the public buy them. Anyone buying these syringes are putting their health and perhaps their lives at risk.

An outbreak of hepatitis B in the Indian state of Gujarat in 2009 was blamed on a combination of doctors reusing syringes and the trade in second-hand syringes. At least 60 people died (Solberg 2009). A newspaper report at the time said that as well as syringes, needles, saline bottles, intravenous drips and vials were all washed and repackaged for resale.

In Mumbai, India, in 2010, police intercepted waste including surgical gloves, syringes, needles, catheters and other medical paraphernalia, which they believe would be reprocessed and sold back to hospitals.

An outbreak of hepatitis B in the Indian state of Gujarat in 2009 was blamed on a combination of doctors reusing syringes and the trade in second-hand syringes. At least 60 people died.

None of these reprocessed products would have been washed with sterile water, or sterilised before packaging. Hence, all bring the risk of infection to the patient.

Figure 23. Transporting waste in a wheelchair- just one of many bad practices that can represent a potential source of infection for patients (Stringer/HCWH).

In Bangladesh, the products repackaged and sold back to healthcare facilities and the public include: syringes, saline bags, plastic materials, cans and other metals (Patwary *et al*. 2011c).

This trade no doubt occurs in many other countries too. Second hand disposable gloves have been seen by the author in markets in Philippines.

The families of waste workers, ragpickers and others who have to work with medical waste are also at risk. If the worker contracts a contagious disease as a result of their work, they can pass that on to those close to them. Another route is from chemicals or pathogens that they bring home on their clothes and bodies.

Medical Staff

According to an unpublished survey by HECAF in Nepal (Nakarmi, 2011, Pers. Comm.) 11% of needle-stick injuries in hospital happened during waste disposal; 22% of injuries amongst medics were during the process of needle recapping, even though they should have been trained not to recap. However, the practice persists, particularly where there are not enough sharps containers or needle cutters.

Gabriel (2009) found that 21% of needle-stick injuries happened during disposal in the UK.

Waste Handlers

Waste workers in general are probably the group whose lives and health are most endangered by improper medical waste treatment. Franka *et al*. (2009) found that medical waste handlers in Tripoli, Libya, had significantly higher levels of hepatitis B and C than waste handlers who had no contact with medical waste. 300 workers were tested in each group. Hepatitis B was 7 times higher in the medical waste handlers (2.3% vs 0.3%).

No odds ratio could be calculated for hepatitis C, because although 2.7% of the medical waste handlers were infected, not one of the non-

medical waste handlers had it. No HIV was detected in any worker. Only 21% of the medical waste handlers had been vaccinated against hepatitis B, and 7% trained to handle waste. In terms of protective clothing, almost all (99.7%) wore overalls when handling waste, but only just over half had gloves (57.7%) and boots (55%). Fewer than one in 5 (17.7%) wore face masks. Libya does not have any regulations on medical waste (Sawalem *et al*. 2008).

Medical waste handlers in Tripoli, Libya, had significantly higher levels of hepatitis B and C than waste handlers who had no contact with medical waste.

Ragpickers

In 2007, *The News* in Pakistan reported that hepatitis C was spreading among young ragpickers as they collected used syringes and other clinical waste. According to the Additional Secretary Health Dr Iqbal Saeed Khan, 50,000 garbage collectors, many of them children, were suspected of being infected.

According to a Pakistani Additional Secretary Health 50,000 garbage collectors, many of them children, were suspected of being infected with hepatitis B.

Discussion and Recommendations

The issue of medical waste needs higher priority at all levels if this unrecognised health threat is to be abated. However, the potential for improvement exists if the right measures are taken.

There needs to be recognition that medical waste management is complex and that, as well as the technical solutions, success is in large part dependent on changing the habits of most of the staff in the facility. This is a neglected aspect of many projects. Hospitals and healthcare facilities will need significant support to develop their new systems, but often a few days of lectures are deemed sufficient. This must change if human rights are to be protected.

Yang *et al*. (2009) predict that, even if incineration is replaced by alternatives in China, life-cycle consideration and holistic approaches-technological verification, facilities operation, environmental supervision and monitoring, training and financial mechanisms as the most important factors in achieving reliable and sustainable healthcare waste management.

Along similar lines, the authors of a 12-country study in Asia concluded that a change in mindset in all concerned stakeholders. They also highlight the need for better budget support, policies and legislation and technology and information management (Ananth *et al*. 2010).

Waste avoidance is always at the top of the waste hierarchy, as the first step that should be taken. Manufacturers can design their products from the least harmful materials available. Hospitals can implement green purchasing procedures and avoid toxic materials such as mercury, and unnecessary disposable products. These are among measures recommended by the International Council of Nurses (ICN 2004).

Prescription practices can be changed, so that where there is more than one drug that will treat the patients' condition, the one with the least environmental impact is chosen. Sharps waste can be reduced dramatically as many injections are unnecessary (see eg ICLEN 2004). Instead, equally effective oral medication can be given to millions of patients each year. This will reduce the number of needle-stick injuries too.

Medical waste management is complex, and success is in large part dependent on changing the habits of most of the staff in the facility. Hospitals and healthcare facilities will need significant support to develop their new systems.

Segregation can prevent ordinary garbage or recyclables being contaminated with infectious material and increasing the amount of waste that needs treating, whilst preserving valuable recyclables.

Better quality control procedures and public education can help people avoid hazardous products. For example, researchers in Pakistan have documented the repackaging of used syringes in Karachi and developed a set of criteria to help distinguish between new and repackaged syringes. Their dissemination and use could significantly reduce this hazard.

Wealthier countries can tighten up their export procedures, in line with the Basel Convention, so that medical waste is not exported illegally and inappropriate and unwanted medications are not sent to create a disposal problem in the places that are least equipped to deal with it.

Finally, good staff training, vaccination, personal protective equipment, post exposure prophylaxis, safety procedures, and non-burn treatment and technology will ensure that the waste that cannot be avoided is treated and disposed of in an economical, safe and environmentally sustainable manner.

Avoiding incineration will result in a significant reduction in pollution of all types. Stringer *et al*. (2010) estimate that the replacement of a single small-scale incinerator with an autoclave, which was successfully demonstrated in Tanzania, avoided the production of approximately 3.8g ITEQ of dioxins and furans per year. Tanzania alone has over 200 hospitals of the same size as the one that participated in the study; promotion of non-incineration technologies would result in a huge reduction in the production of unintentional POPs (Persistent Organic Pollutants, the chemicals targeted by the Stockholm Convention).

Even in the better equipped countries of Europe, there is significant progress to be made. Alvim-Ferraz and Afonso (2004) estimated that strict segregation could reduce the amount of waste incinerated in Portugal by 80%, and by incinerating only what the law demanded, they could reduce emissions of dioxins by 99.5%. Emissions of mercury would be virtually eliminated and emissions of particulate matter, arsenic, cadmium, nickel, sulphur and nitrogen oxides, carbon monoxide and hydrogen chloride each reduced by over 90%.

Current initiatives

There are many places where safe and sustainable medical waste management is practiced, and there are also a number of guidelines and laws which pertain to the issue.

Specific current initiatives include the UNDP/GEF global medical waste management project (GEFmedwaste.org), which is creating model hospitals which are mercury free and have non-incineration medical waste management technologies. This is being carried out in collaboration with the governments of seven project countries: Argentina, India, the Philippines, Latvia, Lebanon and Senegal, with WHO and HCWH as principal cooperating agencies.

In an eighth country, Tanzania, the project is collaborating with the University of Dar es Salaam to design non-incineration waste treatment technology which is economical, robust and easy to maintain. This technology is primarily designed with the African context in mind, and the manufacturing process is also low-tech so that it can be manufactured locally in sub-Saharan Africa, but it will have global application. In advance of the UNDP/GEF global medical waste management project inception, HCWH worked with GEF project members and other local partners to pilot autoclaving of medical waste in Tanzania to prove that the concept was effective in typical district hospital (Stringer *et al*. 2010).

Health Care Without Harm in the Philippines have worked with a number of hospitals over the years and demonstrated how to dispose of the waste from vaccination programmes without incineration (see eg HCWH 2007). They have shown how the creativity of the staff can be engaged in reusing materials and the economic benefit of recycling.

Health Care Foundation Nepal (HECAF) has been working on sustainable medical waste management since 1999. They installed the first non-incineration waste management system in the country at the National Kidney Centre and, amongst other projects, are currently working at Bir Hospital, the oldest and

the largest hospital in Kathmandu. Needles and syringe hubs are cut immediately after use, and waste is rigorously segregated. Infectious waste is autoclaved and cytostatic drugs neutralised. 40% of the total waste stream is sold for recycling, earning the equivalent of almost US$ 15 per bed per year and a biodigester is being constructed to treat organic wastes – mostly food - which make up approximately 25% of the waste that the hospital produces. This will produce compost and biogas, which can be used as a renewable energy source.

Guidelines on how to manage medical waste are widely accessible, from the World Health Organisation (Pruess *et al*. 1999), currently under review, UNDP/GEF project (www.gefmedwaste.org), HCWH (www.noharm.org), and others. The GEF global medical waste management project has created a number of tools and guides which are available on its website, and is also collaborating with the Indira Ghandi National Open University and the University of Chicago on a training course on medical waste management.

These include listings of suppliers of non-incineration medical waste treatment technologies (see eg Emmanuel & Stringer 2007). Promoting them is in line with WHO policy (2004) and the Stockholm Convention, which has been ratified by 173 countries at the time of writing.

The International Federation of Biosafety Associations has declared 2011 the Year of International Biosafety Communities and published a declaration on advancing global biosafety and biosecurity. This seeks to draw attention to the serious dangers that can arise from the failure to implement effective biosafety and biosecurity, and recommends that IFBA act as a vehicle to advance global biosafety. A strategic plan and funding will be required (IFBA 2011). Whether the biosafety issues arising from improper medical waste management will be addressed remains to be seen.

National Policies

Many countries are only now in the process of writing their national policies. When they do, experience tells that they will need significant support to implement them successfully. The table below shows the status of the legislation in one WHO region.

Country	Legislation has been passed	Policy and guideline published	National Committee	Sub-national committee
Bangladesh	In process	2001 and 2004	In process	In process
Bhutan	In process	1998 and 2005	No	No
India	1998	2000 and 2005	Yes	Partially
Indonesia	In process	In process	In process	No
Maldives	In process	In process	Not available	Not available
Myanmar	No	No	No	No
Nepal	In process	In process	In process	In process
Sri Lanka	Yes	2001	No	No
Thailand	2002	2000	In process	In process

Figure 24. Status of national legislation in WHO South East Asia Region 2005 (WHO and FAO 2006)

Today, India is treating approximately half of its waste, whereas Indonesia, Nepal and Bangladesh have not been able to implement their systems successfully at all. Nigeria does not have a policy or plan (Abah & Ohimain 2010) and researchers regard the situation as unsustainable and unable to protect human health and the environment. Other countries without waste treatment regulations include Libya (Sawalem *et al*. 2008) and Serbia (Stankovic *et al*. 2008).

Where policies and plans are in place, there is also often a significant gap between the official reports of implementation and the actual situation on the ground. Ikram *et al*. (2010) who investigated medical waste management status as part of a study on measures to control hospital acquired infections (HAIs) in Northern Punjab (Pakistan) found that although most of the hospitals they surveyed claimed to have segregation systems in place, in reality the necessary coloured bags were not present, sharps could be seen in bins and outside in the garbage, and the hospitals did not even know the ultimate fate of their waste.

Most hospitals in Brazil do not comply with the national legislation (Da Silva *et al*. 2005).

Legislation needs to be enforced, and carry penalties that have real significance for perpetrators. According to *NJ.com*, in New Jersey, USA, legislation is being considered to strip medical practitioners involved in waste dumping of their licences to practice. Penalties of this severity could rapidly change the lax attitudes that currently exist in many places.

Selling second hand medical devices is potentially lethal to whoever is treated with them, but these crimes are rarely, if ever, treated on a par with manslaughter.

A number of country level initiatives demonstrate that incineration is not necessary for safe management of medical waste. The number of medical waste incinerators in the USA has reduced by over 99% since 1998 (See Figure 3 below).

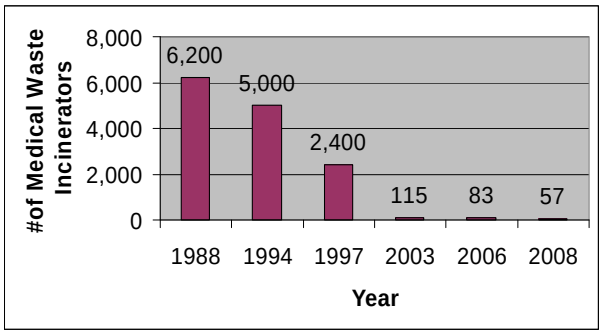

Figure 25. Decrease in the number of medical waste incinerators in the USA. Courtesy J. Emmanuel.

Several Argentinean provinces and districts have passed legislation prohibiting the incineration of infectious waste, proposing the usage of autoclaving for its treatment instead. The Philippines banned the use of incineration of all wastes in 1999. Instead, infectious medical waste is treated with alternative methods, especially autoclaving and microwaving. Both these kill microorganisms through the action of high temperature steam, and shredding of the waste can reduce the volume significantly for subsequent landfilling.

Global Policies and Initiatives

WHO and Health Care Without Harm are running a Global Initiative to eliminate mercury from the health care waste stream. The effort is a component of the UNEP Mercury Products Partnership. The Objective of the WHO-HCWH

Global Initiative to Substitute Mercury-Based Medical devices is to:

By 2017, phase out the demand for mercury-containing fever thermometers and sphygmomanometers by at least 70% and to shift the production of all mercury-containing fever thermometers and sphygmomanometers to accurate, affordable, and safer non-mercury alternatives.

This effort has yielded significant success. In the United States today, it is virtually impossible to purchase a mercury thermometer, while 30 percent of the population lives in states where mercury blood pressure devices (sphygmomanometers) are either banned or severely restricted. In Europe, the EU has banned mercury thermometers and is considering similar restrictions for sphygmomanometers.

Similar policies are emerging in dozens of developing countries. Argentina, Chile, Mongolia and the Philippines are implementing national policies to substitute mercury-based medical devices. The public health systems of several mega-cities, including Delhi, India and Mexico City are making the switch. State or Provincial run health care systems such as Sao Paulo and Santa Catarina in Brazil, and Kwa Zulu Natal in South Africa are phasing out mercury-based medical devices. Hospitals and health systems in countries ranging from Indonesia to Nepal to Thailand to Tanzania are piloting mercury-free health care (HCWH 2010).

Other global instruments relating to medical waste include the Stockholm Convention, the Basel Convention and SAICM.

The Stockholm Convention states that "*priority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of chemicals listed in Annex C*". If incineration is employed, dioxin emissions should be limited to 0.1ng/m^3, which and requires expensive air pollution control devices and is often not achieved even in the most industrialised regions. It is never achievable with the small-scale incinerators that are so widely used in low to middle income countries.

Infectious wastes, mercury-containing wastes and wastes from the manufacturing and use of pharmaceuticals, and waste pharmaceuticals, drugs and medicines are classified as hazardous under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (www.basel.int). However, medical waste is treated mostly within the country where it was generated, so in practice it is rarely invoked.

The Strategic Approach to International Chemicals Management (SAICM) (www.saicm.org) is currently considering a proposal to work on the impacts of environmentally persistent pharmaceuticals.

However, none of these instruments directly addresses the issue of medical waste as a whole, and hence it remains a low priority for the international regulatory community. One of the consequences of this is that very little funding is available for it. The current global financial crisis has already affected health sector financing in parts of Africa (Kirigia *et al*. 2011) and there are bound to be similar impacts in other low to middle income countries. This makes a proper funding mechanism for medical waste management particularly important.

The World Health Assembly (WHA 2010) also called for more action on medical waste. The preamble of the resolution notes that the Assembly was:

"*aware that wastes, if not properly managed, in a safe and environmentally sound manner, may have serious consequences for human health and livelihood;*

Convinced that the lack of environmentally sound management of waste will harm the environment and be detrimental to human

health, through polluted air, water and land and food chain;

Concerned that poor management of health-care waste, including sharps, non-sharp materials, blood, body parts, chemicals, pharmaceuticals, and medical devices puts health-care workers, waste handlers and the community at risk of infections, toxic effects and injuries;"

Amongst other things, the resolution calls on member states to "*assess the health aspects of waste management in order to make it safe and environmentally sound and to explore options to work more closely with the United Nations Environment Programme, the Strategic Approach to International Chemicals Management, the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal and the WHO Secretariat towards achieving their shared objectives on the improvement of health through safe and environmentally sound waste management*"

The Stockholm Convention prioritises non-incineration technologies.

If incineration is employed, dioxin emissions should be limited to 0.1ng/m^3, which is never achievable with the small-scale incinerators that are so widely used in low to middle income countries.

The Need for Action

For these various policies to have the desired effect, however, number of fundamental issues need to be addressed at all levels. These include: funding; technical and implementation support; and political priority and enforcement.

Regarding funding, there needs to be an effective financial mechanism to make sure that the resources to address the problems are present. To date, far too few resources are dedicated to dealing with medical waste. Governments, intergovernmental agencies, donor agencies, hospitals and medical product manufacturers all need to do their part. All ministries of health and healthcare facilities need to have a dedicated budget for waste management. This is necessary for the proper tracking of expenditure, but will also avoid the impression that money spent on waste is diverted from other aspects of healthcare.

WHO addresses this in its 2007 core principles (WHO 2007), which states:

"*The WHO core principles require that all associated with financing and supporting health-care activities should provide for the costs of managing health-care waste. This is the duty of care. Manufacturers also share a responsibility to take waste management into account in the development and sale of their products and services. The establishment and sustained maintenance of sound systems for health-care waste management depend on the availability of resources. Therefore, in keeping with the WHO core principles, WHO recommends that:*

Governments should:

- *allocate a budget to cover the costs of establishment and maintenance of sound health-care waste management systems*
- *request donors, partners and other sources of external financing to include an adequate contribution towards the*

management of waste associated with their interventions
- *implement and monitor sound health-care waste management systems, support capacity building, and ensure worker and community health.*

Donors and partners should:

- *include a provision in their health program assistance to cover the costs of sound healthcare waste management systems.*

Non-governmental organizations should:

- *include the promotion of sound health-care waste management in their advocacy*
- *undertake programs and activities that contribute to sound health-care waste management.*

The private sector should:

- *take responsibility for the sound management of health-care waste associated with the products and services they provide, including the design of products and packaging.*

All concerned institutions and organizations should:

- *promote sound health care waste management*
- *develop innovative solutions to reduce the volume and toxicity of the waste they produce and associated with their products*
- *ensure that global health strategies and programs take into account health-care waste management."*

Financial consideration of medical waste management also needs to take into account the distorting effect of the informal economy that exists in so many places. When there are people who are willing to pay for the waste, it should come as no surprise that facilities are reluctant to pay for it to be taken away, or that poorly paid workers sell it, or that the dispossessed scavenge it.

Another key issue is technical and implementation support. The technologies to treat medical waste safely, such as autoclaves and the equipment needed to test them, are already well within our reach. However, there is still not enough support for the non-incineration technologies which are recommended by WHO and the Stockholm Convention. For example, it is estimated that there are 1000 incinerators in Africa (AGENDA 2009) but only about 50 alternative installations. Expertise exists to install, validate and monitor treatment equipment, but it is often not available to those that need it.

Even then, it must be recognised that the equipment is only one part of the system. As can be seen in this report, many different people are involved in the chain of medical waste management, and will need to be involved in the solution. This behaviour change will take more time, but it must not be neglected, or the situation will remain as it is now.

A medical waste recycler commented:

"if it is risky for the people, why don't they [senior management of healthcare establishments] *keep these items securely and dispose of them safely?.....why do they* [health care workers] *sell them to us?"*

The final element is political priority. Too many politicians, environment and health inspectors, and hospital directors are simply not addressing this problem. This need for political priority can be expressed in legislation, but too often national legislation is not being implemented.

Any people who are potentially at risk form medical waste need to be properly informed of the risks, and given the training and equipment to protect themselves.

Compliance with the legislation needs to be monitored closely and rigorously enforced. This is made harder by poor governance and corruption.

Research in Bangladesh has thrown light on practices which no doubt occur in many low to middle income countries. There is a well-established underground economy based on reusing medical waste. Ragpickers, waste traders and recyclers, truck drivers, drug dealers, pharmacists, healthcare workers, healthcare facility managers and even local authority staff are all implicated in the business. Lack of secure waste storage or proper waste disposal, corruption, lack of personal responsibility and accountability were all factors in the continuation of this dangerous waste trade (Patwary *et al*. 2011a).

But if there are many involved in the trade, there are some who have a greater power, and therefore responsibility, to prevent it. As one medical waste recycler commented during an interview with researchers:

"*if it is risky for the people, why don't they* [senior management of healthcare establishments] *keep these items securely and dispose of them safely?.....why do they* [health care workers] *sell them to us?"*

Another said: "*…if this is illegal, why don't they* [senior management of healthcare establishments] *prevent it? I have seen and also know that some of the senior management officials are involved in this activity. The business is operating with their consent. They take a share of the proceeds of waste selling from their junior operatives and a number of gangs who control waste selling. If you say this is illegal, you have to tell these corrupt people before you tell us."*

Practices that interfere with people's enjoyment of their rights to life, heath, a safe workplace and a healthy environment need to be prohibited, preferably at the international level, and rigorously enforced by the national and international authorities.

It is clear that current international legislation and initiatives do not yet have enough force or capacity to cope with the global burden of medical waste. One legal mechanism may be effective is to supplement the existing provisions of the Basel and Stockholm Conventions to allow them to work together to address the issue more directly and comprehensively. Labour organisations and medical profession associations could also raise their level of vigilance and instigate measures to reduce the amount and impacts of medical waste.

Unless there is concerted, mandatory action on medical waste, efforts to strengthen global health systems will be undermined and hospitals become an increasingly significant source of disease to the community.

It is also important that the whole medical waste stream be addressed. As can be seen in the literature reviewed here, most of the research relating to medical waste deals with sharps waste, and its impacts on medical and other staff. This is a natural extension of the need to address unsafe injections, which are a major source of illness and results in literally millions of deaths. However, this skewing of the literature means that the harm from other sorts of medical waste can appear to be insignificant, when in fact they are simply not understood. Indeed, some research papers that discuss the harm from sharps waste are in fact reporting the harm from *all* wastes.

This is not to downgrade the hazards associated with sharps waste, but to highlight the need to deal with medical waste in a holistic manner. If sharps waste is contained and destroyed, but other infectious waste, pathological waste and chemical and radioactive wastes are not dealt

with concomitantly, the risks to human rights will remain.

There are a number of technical solutions to treating medical waste. However, enacting proper medical waste management requires the support of management and medical staff as well as the waste handlers, and achieving and maintaining the change in staff and management attitude and behaviour required to handle medical waste is often far more difficult than specifying supplying the necessary equipment.

In almost every healthcare structure there will be staff who claim they are too busy to segregate the waste they produce, or do not think that the health of the municipal worker who is exposed to hazardous materials is their concern. Addressing one type of waste and neglecting the others supports gives tacit support to these views.

Conversely, treating all medical wastes as equally important and needing proper handling cultivates a culture where cleanliness of and pride in the maintenance of the hospital, which can have wide-ranging benefits, from a reduction in vermin coming to seek out food waste to a reduction in nosocomial infections.

Until concrete and substantial steps are taken, the problem of medical waste will not abate, but grow worse as waste volumes increase year by year, and human rights will be infringed on an ever greater scale.

Until concrete and substantial steps are taken, the problem of medical waste will not abate, but grow worse as waste volumes increase year by year, and human rights will be infringed on an ever greater scale. This cannot be allowed to continue. The time for complacency is over; the time to act is now.

References

- Abah, S.O. & Ohimain, E.I. (2011) Healthcare waste management in Nigeria: a case study. Journal of Public Health & Epidemiology 3(3): 99-110
- AERB (2010) Press Release: Incidents of Radioactive materials discovered in scrap dealers shops in New Delhi. Publ: Government of India Atomic Energy Regulatory Board, 1pp. http://www.aerb.gov.in/t/prsrel/p2942010.pdf
- Allsopp, M., Costner, P. & Johnston, P. (2001) Incineration and human health: State of Knowledge of the Impacts of Waste Incinerators on Human Health. Publ: Greenpeace Research Laboratories, Univ. Exeter, UK, 84pp. ISBN: 90-73361-69-9, http://www.greenpeace.to/greenpeace/?p=1059
- Altaf, A., Janjua, N.Z., Dr Aamir Javed Khan, Mujeeb, S.A. & Samad, L. (2004) An Assessment of the Quality of Syringes in Pakistan. Study conducted by Safe Injection Network, Karachi, Pakistan funded by World Health Organization, 30pp.
- Altaf, A.& Mujeeb, S.A. (2002) Unsafe disposal of medical waste: a threat to the community and environment. J.Pak.Med.Assoc. 56(2) 232-233
- Alvim-Ferraz, M.C.M. 7 Afonso, S.A.V. (2005) Incineration of healthcare wastes: management of atmospheric emissions through waste segregation. Waste Management 25(6): 638-648
- Ananth, P.A., Prashanthini, V., Visvanathan, C. (2010) Healthcare waste management in Asia. Waste Management 30(1): 154-161
- Anon (2011) Poor Medical Waste Disposal Standards Causing Health Problems In India. Waste Management World, 10 January 2011, http://www.waste-management-world.com/index/display/article-display/_printArticle/articles/waste-management-world/biological-treatment/2011/01/Poor_Medical_Waste_Disposal_Standards_Causing_Health_Problems_in_India.html
- Appleton, J. & Ali, M. (2000) Healthcare or Health Risks? Risks from Healthcare Waste to the Poor, Publ: Water Engineering and development Centre, Loughborough University, UK, 32pp. http://www.lboro.ac.uk/orgs/well/resources/well-studies/full-reports-pdf/task0326.pdf
- Askarian, M., Vakili, M. & Kabir, G. (2004) Results of a hospital waste survey in private hospitals in Fars province, Iran. Waste Management 24(4) 347-352
- Batterman (2004) Assessment of small-scale incinerators for healthcare waste/ Publ: WHO, Geneva, 69pp. http://www.who.int/immunization_safety/publications/waste_management/en/assessment_SSIs.pdf
- Bengtsson, B-E., Gunnarsson, B., Wall, T., Wennmalm, A. (2006) Environment and Pharmaceuticals. Publ: APOTEKET AB, Stockholm County Council & Stockholm University, ISBN: 91-85574-55-4, 142pp.
- Blenkharn, J. I. & Oakland, D. (1989) Emission of viable bacteria in the exhaust flue gases from a hospital incinerator. J. Hospital Infection. 14(1): 73-78
- Blenkharn, J. I. & Odd, C. (2008) Sharps Injuries in Healthcare Waste Handlers. Ann. Occup. Hyg. 52(4): 281-286
- Brenda, T., Moro, P.L., Hancy, K. Ortega-Sanchez, I.R., Santos-Preciado, J.I.,, Franco-Paredes, C., Weniger, B.G. & Chen, R.T.(2010) Needlestick injuries among sanitation workers in Mexico City Revista Panamericana de Salud Pública 27: 467-468
- Chomel, B. B., Belotto, A., Meslin, F. X. (2007) Wildlife, exotic pets, and emerging zoonoses. Emerg Infect Dis. 13(1):6-11
- Da Silva, C.E., Hoppe, A.E., Ravanello, M.M., & Mello, N. (2005) Medical wastes management in the south of Brazil. Waste Management 25(6): 600-605
- Emmanuel, J. & Stringer, R. (2007) For Proper Disposal: A Global Inventory of Alternative Medical Waste Treatment Technologies. Publ: Health Care Without Harm, 52pp. http://www.noharm.org/lib/downloads/waste/For_Proper_Disposal.pdf
- Franka, E., El-Zoka, A. H., Hussein, A. H., Elbakosh, M. M., Arafa, A. K., Ghenghesh, K. S (2009) Hepatitis B virus and hepatitis C virus in medical waste handlers in Tripoli, Libya. Journal of Hospital Infection 72(3): 258-261

- Grebnicoff , A.(2006) Presentation by Dr. Dra. Adriana Grebnicoff, Ministerio de Salud del GCBA, Coordinación de Salud Ambiental, Primera Conferencia Latinoamericana sobre la Eliminación del Mercurio en el Cuidado de la Salud, Buenos Aires, August 5, 2006.
- Harhay, M.O., Halpern, S.D., Harhay, J.S. & Olliaro, P.L. (2009) Health care waste management: a neglected and growing public health problem worldwide. Tropical Medicine and International Health 14(11): 1414-1417
- Hassan, M.M., Ahmed, S., Rahman, K.A. & Biswas, T. (2008) Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh. BMC Public Health 8(1): 36-45.
HCWH (2010) Toward the tipping point. WHO-HCWH Global Initiative to Substitute Mercury-Based Medical Devices in Health Care. A Two-Year Progress Report. http://www.noharm.org/lib/downloads/mercury/Toward_the_Tipping_Point.pdf
- HCWH (2007a) Making Medicine Mercury-Free, A Resource Guide for Mercury Free Medicine, in Going Green: A Resource Kit for Pollution Prevention in Health Care, Health Care Without Harm, Arlington, June 6, 2007, http://www.noharm.org/goinggreen
- HCWH (2007b) Best practices in health care waste management. Examples from four Philippines hospitals. 69pp. http://noharm.org/lib/downloads/waste/Best_Practices_Waste_Mgmt_Philippines.pdf
- HCWH (2004) Waste Management and Disposal During the Philippine Follow-Up Measles Campaign 2004. 112pp, http://noharm.org/lib/downloads/waste/Waste_Mgmt_PMEC_2004.pdf
- HCWH (2003) Cited in "A New Era: The Elimination of Mercury Sphygmomanometers," in Going Green, A Resource Kit for Pollution Prevention in Health Care, Health Care Without Harm, Arlington, http://www.noharm.org/lib/downloads/mercury/A_New_Era_Mercury_Elimination.pdf
- HCWH/CAATA (2007a) Progress Report to the Commission on Environmental Cooperation: Partnership Project to Reduce Use, Discharges and Emissions of Toxic Substances in the Healthcare Sector in Mexico, With an Emphasis on Mercury Reductions," Mexico City/Buenos Aires, July 2007.
- HCWH/CAATA (2007b) "Progress Report," July 2007.
- Health Canada: (2007) Mercury in the Environment http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/mercur/q47-q56_e.html. Page last updated 14 Dec 2007.
- High Court of Sindh of Karachi, 22 December 2010 Decision in the
- Hodges, S. (2008) Chennai's biotrash chronicles: chasing the neo-liberal syringe. GARNET Working Paper 44/08, 28pp, http://www.garnet-eu.org/fileadmin/documents/working_papers/4408.pdf
- ICN (2004) Medical Waste: Role of Nurses and Nursing. ICN Position. 2pp. http://www.noharm.org/lib/downloads/waste/Medical_Waste_Role_of_Nurses.pdf
- IndiaCLEN (2004) Assessment of Injections safety practices in India. India Clinical Epidemiology Network, 245 pp, http://www.google.co.uk/url?sa=t&source=web&cd=5&sqi=2&ved=0CEEQFjAE&url=http%3A%2F%2Fwww.ipen.org.in%2Fdownloads%2FPDF%2FAIPI.pdf&rct=j&q=indian%20clinical%20epidemiology%20network%20waste-pickers&ei=LMjGTfvQB8Tr0gHenoGCCA&usg=AFQjCNHJW7FTx9Jglgkuf8xH-v3N96jMiw&cad=rja
- IFBA (2011) The IFBA declaration on advancing biosafety and biosecurity. Publ: International Federation of Biosafety Associations. February 17, 2011, 3pp. http://www.internationalbiosafety.org/English/pdf/2011/2011-IFBA-Declaration-Feb-Rev2.pdf, and http://www.internationalbiosafety.org/english/index.asp
- IIM (2010) Evaluation of Central Pollution Control Board (CPCB). Submitted to Ministry of Environment and Forest by Indian Institute of Management, Lucknow, Feb 2010. 125pp. www.moef.nic.in/downloads/public-information/Rpt_CPCB.pdf
- Ikram, A., Hussain Shah, S.I., Naseem, S., Absar, S.F., Ullah, S., Ambreen, T.
- Sabeeh, S.M. & Niazi, S.K. (2010) Status of hospital infection control measures at seven major tertiary care hospitals of northern Punjab. J Coll Physicians Surg Pak. 20(4): 266-70
- IPEN (2005) Contamination of chicken eggs near the Queen Mary's Hospital, Lucknow medical waste incinerator in Uttar Pradesh (India) by dioxins, PCBs and hexachlorobenzene. Publ: International POPs Elimination Network, 25pp, http://www.ipen.org/ipepweb1/library/ipep_pdf_reports/3ind%20lucknow_eggsreport.pdf
- Kirigia, J., Nganda, B., Mwikisa, C., Cardoso, B. (2011) Effects of global financial crisis on funding for health development in nineteen countries of the WHO African Region. BMC International Health and Human Rights 11(1): 4-23

- Kumar, B., Kumar, S., Lal, R.B., Prakash, D., Pathak, A., Sharma, C.S., Makhijani, S.D., Kamyotra, J.S., Guatam, S.P. (2009) Emission levels of polychorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/PCDFs) from waste incinerators in India. Organohalogen Compounds 71: 194-197
- Kumar, S., Lal, R.B., Kumar, B., Sharma, C.S., Makhijani, S.D., Kamyotra, J.S.
- Gautam, S.P. (2009) Identifying the contributing sources of PCDDs/PCDFs by comparison of congener distribution profiles observed in respirable suspended particulate matter sampled from ambient air of Delhi. Organohalogen Compounds 71: 183-186
- Liu, Y., Zhan, Z., Du, F., Kong, S., Liu, Y. (2009) Indoor air concentrations of mercury species in incineration plants for municipal solid waste (MSW) and hospital waste (HW). Chemosphere 72(2): 266-271
- Manyele, S.V. & Lyasenga, T.J. (2010) Factors affecting medical waste management in low-level health facilities in Tanzania. African Journal of Environmental Science and Technology 4(5): 304-318
- MoEF (1998) Bio Medical Waste (Management, Handling) Rules. Publ. Indian Ministry of Environment and Forests. www.envfor.nic.in/legis/hsm/biomed.html
- Mujeeb, S.A, Adil, M.M., Altaf, A., Hutin, Y. & Luby, S. (2003) Recycling of injection equipment in Pakistan. Infection Control and Hospital Epidemiology 24(2): 145-146
- Mujeeb, S.A, Adil, M.M., Altaf, A., Shah, S.A. & Luby, S. (2003) Infection Control Practices in Clinical Laboratories in Pakistan. Infection Control and Hospital Epidemiology 24(2): 141-142
- Muliartha, I Nengah. (2008). (dissertation in Bahasa). Medical Wastes Management of Wangaya General Public Hospital in Denpasar. Master dissertation. Publ: Udayana University. Denpasar, Indonesia Pengelolaan Limbah Medis RSUD Wangaya di Denpasar. Master Disertasi. Universitas Udayana. Denpasar.
- Ndidi, N., Nelson, O., Patricia, O. & Sunday, J. (2009) Waste management in healthcare establishments within Jos Metropolis, Nigeria. African Journal of Environmental Science & Technology 3(12): 459-465
- Novais, C., Coque, T.M., Ferreira, H., Sousa, J.C. & Peixe, L. (2005) Environmental Contamination with Vancomycin-Resistant Enterococci from Hospital Sewage in Portugal. Appl. Environ. Microbiol. 71(6) 3364-3368
- Oh, P., Granich, R., Scott, J., Sun, B., Joseph, M., Stringfield, C., Thisdell, S., Staley, J., Workman-Malcolm, D., Borenstein, L., Lehnkering, E., Ryan, P., Soukup, J., Nitta, A. & Flood, J. (2002) Human exposure following Mycobacterium tuberculosis infection of multiple animal species in a Metropolitan Zoo. Emerg. Infect. Dis. 8(11): 1290-3
- Pastore, P., Singh, R. & Jain, N. (2007) Mercury in Hospital Indoor Air: Staff and Patients at Risk, Toxics Link, New Delhi, January 2007.
- Patwary, M.A., O'Hare, W.T. & Sarker, M.H. (2011a) An illicit economy: Scavenging and recycling of medical waste. Journal of Environmental Management. In Press, corrected proof: doi: 10.1016/j.jenvman.2011.06.051
- Patwary, M.A., O'Hare, W.T. & Sarker, M.H. (2011b) Occupational accident: An example of fatalistic beliefs among medical waste workers in Bangladesh. Safety Science In Press, http://hdl.handle.net/10149/135631
- Patwary, M.A., O'Hare, W.T. & Sarker, M.H. (2011c) Assessment of occupational and environmental safety associated with medical waste disposal in developing countries: a qualitative approach. Safety Science 49: 1200-1207
- Pers. Comm. (2007) Personal Communication between Rico Euripidou, groundWork, South Africa and Louis Havinga, Manager, Health Technology Services, KwaZulu Natal Department of Health, Durban, June 20, 2007.
- Pruess, A., Giroult, E. & Rushbrook, P. (1999) Safe management of wastes from healthcare activities. WHO - Geneva ISBN 92 4 154525 9, 228pp
- Rahman, M.F, Yanfula, E.K. & Jasim, S.Y. (2010) Occurrences of endocrine disrupting compounds and pharmaceuticals in the aquatic environment and their removal from drinking water: Challenges in the context of the developing world. Desalination 252: 161-168
- Ramokate, T. & Basu, D. (2009) Health care waste management at an academic hospital: knowledge and practices of doctors and nurses. 99(6): 444-445
- Reid, S. (2010) Preliminary results of the update of the WHO Global burden of disease from unsafe medical injections. Presentation to the Safe Injection Global Network Annual Meeting, 9-11 November, Dubai, UAE

- Rolain, J. M., Parola, P., Cornaglia, G. (2010) New Delhi metallo-beta-lactamase (NDM-1): towards a new pandemia? Clinical Microbiology and Infection 16(12): 1699-1701
- Sabiha-Javied, Tufail, M. & Khalid, S. (2008) Heavy metal pollution from medical waste incineration at Islamabad and Rawalpindi, Pakistan. Microchemical Journal 90(1): 77-81
- SCC (2009) Environmentally classified pharmaceuticals. Publ: Stockholm County Council, 40pp
- Solberg, K.E. (2009) Trade in medical waste causes deaths in India. Lancet 373: 1067
- Stankovic, A., Nikic, D. & Nikolic, M. (2008) Treatment of medical waste in Nisava and Toplica districts, Serbia. Waste Management and Research 26(3): 309-313
- SCC (2009) Environmentally classified pharmaceuticals. Publ: Stockholm County Council, 40pp
- Stringer, R., Kiama, K., Emmanuel, J., Chenya, E., Katima, J & Magoma, F. (2010) Non-Incineration Medical Waste Treatment Pilot Project at Bagamoyo District Hospital, Tanzania. Publ: Health Care Without Harm, 37pp. http://noharm.org/lib/downloads/waste/Bagamoyo_Pilot_Project_Report.pdf
- Stringer, R. & Johnston, P. (2001) Chlorine and the environment: An overview of the chlorine industry. Kluwer Academic Publishers, ISBN 0-7923-6797-9, 429pp
- SSC (2008) Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants: Waste incinerators. Publ: Secretariat of the Stockholm Convention on Persistent Organic Pollutants, 69pp. http://chm.pops.int/Programmes/BAT/BEP/Guidelines/tabid/187/language/en-GB/Default.aspx
- Thompson, J. & Anthony, H. (2008) The Health Effects of Waste Incinerators: 4th report for the British Society for Ecological Medicine. Second Edition. Publ: British Society for Ecological Medicine. http://www.noharm.org/lib/downloads/waste/Health_Effects_of_Incinerators.pdf
- UNEP (2007) Decisions of the Governing Council. http://www.chem.unep.ch/mercury/Decision%2024-3.pdf
- UNEP (2002) Global Mercury Assessment, UNEP Chemicals, Geneva, December 2002. http://www.unep.org/hazardoussubstances/Mercury/MercuryPublications/ReportsPublications/GlobalMercuryAssessmentReportDecember2002/tabid/3617/language/en-US/Default.aspx
- USEPA (2010) Mercry: Health Effects. http://www.epa.gov/mercury/effects.htm. Page last updated 1 Oct 2010
- USEPA (2000) Exposure and Human Health Reassessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and related compounds. Draft Final report, EPA/600/P-00/001Bb. www.epa.gov/ncea
- USEPA (1996) Mercury Study Report to Congress. Publ: U.S Environmental Protection Agency Science Advisory Board Review Draft, Vol.2, p. 4-19, p. ES-3.
- Uysal, F. & Tinmaz, E. (2004) Medical waste management in Trachea region of Turkey: suggested remedial action. Waste Management & Research 22: 403-407
- Vallini, G. & Townend, W. (2010) Pharmaceutical waste: as in the Titanic we are only seeing the tip of the iceberg. Waste Management & Research 28(9): 767-768
- WHA (2010) Improving health through safe and environmentally sound waste management. World Health Assembly 126th Session, 22 January 2010, EB126.R12, document EB126/20. 3pp, http://apps.who.int/gb/ebwha/pdf_files/EB126/B126_R12-en.pdf
- WHO (2011) World health statistics 2011. Publ: World Health Organisation, Geneva, 171pp, http://www.who.int/whosis/whostat/en/
- WHO & FAO (2006) Sound management of hazardous wastes from health care and from agriculture, Joint WHO and FAO Regional Workshop, Jakarta, Indonesia, June 2006, Publ: WHO SEARO, New Delhi, 72pp. http://www.searo.who.int/LinkFiles/Publications_and_Documents_Hazardous_Report.pdf
- WHO (1999) Guidelines for Drug Donations. Publ: World Health Organisation, Geneva, 24pp. http://apps.who.int/medicinedocs/pdf/whozip52e/whozip52e.pdf
- WHO (1999) Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies. Publ: World Health Organisation, Geneva, WHO/EDM/PAR/99.4, http://apps.who.int/medicinedocs/pdf/whozip52e/whozip52e.pdf
- WHO (2007) Core Principles for achieving safe and sustainable management of health-care waste. Publ: World Health Organisation, Geneva, 2pp, http://www.who.int/water_sanitation_health/medicalwaste/hcwprinciples.pdf
- WHO (2004) Safe Health-care waste management policy paper. 2pp. http://www.who.int/water_sanitation_health/medicalwaste/en/hcwmpolicye.pdf

- Yang, C., Peijun, L., Lupi, C., Yangzhao, S., Diandou, X., Qian, F. & Shaha, F. (2009) Sustainable management measures for healthcare waste in China. Waste Management 29(6): 1996-2004

Press Articles

Afghanistan
Afghanistan Today, Afghanistan, 7 Dec 2010, The underbelly of the recycling industry. more

Argentina
Diario de La Pampa, La Pampa, Argentina, 13 April 2011, Retroceso contra la concentración de residuos Hospitalarios. more
Sin Mordanza, Santa Fe, Argentina, 28 October 2010. Reunión de autoridades sobre tratamiento de residuos hospitalarios. more

Bangladesh
The Daily Star, Bangladesh, 6 April 2011. Medical waste up for sale. more
The Daily Star, Bangladesh, 7 March 2011. Hospital in need of care: ill-equipped Infectious Diseases Hospital fails to provide comprehensive treatment. more

Canada
Time Healthland, 12 May 2011. Thought Bedbugs Were Bad? Try Bedbugs with MRSA. More
Toronto Sun, 14 January 2010. Medical waste dumped in Scarborough. More

Cambodia
The Phnom Penh Post, Cambodia, April 2010. Incinerator Planned. more

China
Global Times, China, 21 October, 2010. Dirty Cover-up. more
Global Times, China, 16 September 2010. Medical Waste Illegally Disposed in Henan. more
The Poch Times, China, 14 June, 2010. Live Baby Treated as Medical Waste. more
Global Times,China, 4 Apr 2010. 21 infants dumped as 'medical waste'. more
The New York Times, USA, 11 Aug 2009. China's Incinerators Loom as a Global Hazard. more
Global Times, China17, Nov2009. New incinerator becomes burning issue for Changping residents. more
The Global Times, China, 7 May 2009. Hospital workers sell toxic trash for cash. more

Colombia
Diario del Norte, Colombia, 15 April 2011. Desechos hospitalarios fueron encontrados a orillas del río Villanueva por tercera vez. more
RCN Radio, Colombia, 13 April 2011. Advierten daños ambientales por incineración de desechos hospitalarios en Fontibón. more

Costa Rica
Business News Americas, Costa Rica, 13 November 2009. CCSS niega acusaciones de descarga de desechos hospitalarios. more

Ecuador
La Hora, Ecuador, 23 April 2011. Peligro por desechos hospitalarios. **more**

El Salvador
La Prensa Gráfica, San Salvador, El Salvador, 19 April 2011. Licitan servicio para tratar desechos de hospitales. more

Honduras

La Prensa.hn, Honduras 8 Oct 2010. Deficiente el manejo de desechos de salud. more
La Prensa, Honduras,3 October 2010. Organización Panamericana de la Salud reporta mal manejo de desechos. more

India

Waste Management World.com, accessed 31 June 2011. Medical Waste Illegally Dumped in Kolkata India. more
Blog by Brooks Anderson, India18 May 2011. Pondicherry's Truck Terminal: A Major Illegal Medical Waste Dumpsite and Source of Dioxin Related-Compounds. more
Ahmedabad Mirror.com, India, 16 April 2011. LG Trashes rules for med waste. more
The Times of India, India, 26 March 2011. Civil Hospital gets notice over effluent plant. more
The Times of India, India, 25 March 2011. Hospital Faces Actions for Dumping Medical Waste in Open Area. more
The India Times, India, 4 March 2011. Hygiene Goes For a Toss as Hospitals Dump Bio-waste. more
Business Standard, India, 5 March 2011. Health Care Waste Management: Unhealthy Silence. more
Times of India, Bangalore, India, 25 February 2011. Ensure Scientific Disposal of Bio-medical Waste .more
The Times of India, India, 7 March 2011. Hospital Waste Management Should Be Neatly Planned. more
Pune Mirror, Pune, India, 15 February 2011. Sick Hospital Infects Staffers. more
Kashmir Life, Kashmir, 11 January 2011. State of Health, Biomedical Waste. more
Waste-Management World, International, 10 January 2011. Poor Medical Waste Disposal Standards Causing Health Problems. more
NDTV, India, 28 December 2010. Notice to Six Private Hospitals for Poor Medical Waste Disposal. more
MedIndia, India, 16 December 2010. Disposal of Bio-medical Waste, a Problem. more
The Times of India, India, 15 December 2010. Hospitals Flouting Biomedical Waste Management Norms. more
IPSNews, India, 14 December 2010. Waste–to–Energy Plants Face Public Heat. more
E-Pao, India, 14 December 2010. Bio–medical Waste Management in Healthcare Discussed. more
Mid-Day.com, India, 3 Dec 2010. Reused hospital waste threat to patients: Cops. more
Bio-medical Hospital Waste Dumped in a House in the Area
NDTV, Mumba, India, 2 December 2010. Bio-medical Hospital Waste Dumped in a House in the Area. **more**
Indian Express, India, 17 November 2010. Firm Says Hospitals Violate Biomedical Waste Disposal Norms. more
Greater Kashmir, Srinagar, India, 4 November 2010. SPCB Busts Hospital Waste Racket. more
Sify News, New Delhi, India, 30 October 2010. Medical Waste Must be Managed Effectively. more
Daily News Analysis, India, 12 October 2010. 50% of Mumbai Hospitals Don't Heed PCB's Norms of Treatment and Disposal of Bio-medical Waste. more
Down to Earth, India, October 2010. India: Biomedical Waste Management System Fails to Take Off in Tripura. more
Indian Express, India, 30 September 2010. Hospital Running Without Authorisation for Disposal of Biomedical Waste. more
The Times of India, Gurgaon, 23 September 2010. Despite Notice, Government Hospital Dumps Waste. more
The Times of India, India, 16 September 2010. Six City Hospitals Served Notice for Faulty Bio-medical Waste Disposal. more
The Statesman, Kolkata, 2 September 2010. Pollution Control Board Lodges FIR Against Biomedical Waste Dealer. more
Waste Management World, International, September 2010. Medical Waste Illegally Dumped in Kolkata. more
The New Nation, India, September 2010. Minister Leaves for India to See Medical Waste Management. more
Nagaland Post, India, 31 August 2010. Untreated Bio-medical Waste. more
The Morung Express, Kohima, 26 August 2010. Pollution Control Board Contributes More to State. more

The Times of India, Margao, 18 August 2010. Hospital Dumps Bio-medical Waste in the Open Ground. more
The Times of India, India, 12 August 2010. Bio-medical Waste Disposal Success Story Offers Hope. more
The Times of India, Pune, 8 July 2010. Only 1,393 Units in Pune Opt for Bio Medical Waste Disposal. more
Mid Day, India, 29 June 2010. Hospital Dumps Dead Embryo Among Other Medical Waste on Roadside. more
DNA India, India, 23 June 2010. Bio-medical Waste Seized from Ahmedabad Godown. more
Nagaland Post, India, 7 May 2010. Bio-medical Waste Threatening Environment. more
The Hindu, India, 3 May 2010. Guidelines on Bio-medical Waste Disposal Needed. more
Indian Express, India, 3 May 2010. India: Government Out to Clean Up Hospital Wasteland. more
The Hindu, India, 1 May 2010. Lessons from Mayapuri. more
The Hindu, India, 13 April 2010. Study, 50% of Bio-medical Waste Dumped With Municipal Garbage. more
Indian Express, India, 12 April 2010. No Agency to Monitor Radioactive Bio-waste. more
The Sunday Times, UK, 11 March 2009. Hepatitis B kills 57 in lucrative Indian trade in recycled medical waste. more
MedIndia, India, 11 April 2008. Mumbai Doctors Grumble About Stiff Fines for Bio-medical Waste. more
MyHimachal, 28 December 2007. Medical waste an environmental hazard in Himachal. more

Indonesia

The Jakarta Post, Indonesia, 6 Aug 2010. Government to Report on Hazardous Medical Waste. more
Jakarta Globe, Indonesia, Indonesia, 5 August 2010. Hospitals Put Public Health at Risk With Lax Handling of Biomedical Waste. more
The Jakarta Post, Indonesia, 11 Jun 2010. Bali in need of better medical waste management: NGO. more

Iran

Tehran Times, Tehran, Iran 5 Oct 2010. Medical Waste Disposal Crisis Looms in Tehran. more

Israel

Jerusalem Post, Israel, 3 Oct 2010. Conference Addresses Growing Issue of Medical Waste. more

Mexico

Noticias Net, Mexico, 17 April 2011. Tiran hospitales residuos tóxicos en papeleras. more
E-Consulta, Mexico, 2 February 2011. Fija Profepa meta de 200 inspecciones por residuos hospitalarios. more

Nepal

Himalayan News Service, Nepal, 9 May 2011. Replace mercury thermometers. more

Nicaragua

La Prensa, Nicaragua, 11 December 2010. Salud pública y ambiental amenazada por desechos sanitarios. more

Nigeria

Daily Independent Online, Nigeria, 20 October 2010. Minister of Environment Seeks Proper Disposal of Medical Waste. more

Pakistan

The News, Pakistan, 03 March 2011. Experts call for prioritising hospital waste management. more
The Express Tribune, Pakistan, Islamabad, Pakistan, 28 Feb 2011. Hazards of Burning Trash. more
The International News, Pakistan, 02 Feb 2011. Drive to ensure waste management rules. more
The International News, Pakistan, 01 Feb 2011. Hospital waste management a far cry. more

High Court of Sindh of Karachi, 22 December 2010, C.P. No D.-363/2008
Dawn, Pakistan, 7 Dec 2010. Hospitals told to prepare waste disposal plan. moreDawn, Peshawar, Pakistan, 6 December 2010. Hospitals Told Use Incinerators not Considering Environment nor Health. more
The International News, Pakistan, March 2010. 22 Hospitals Fined for Poor Waste Handling. more
Pro bono petition filed at the Hon'ble High Court of Sindh at Karachi by Qazi Ali Athar, Advocate. "612" Government and private run hospitals in Karachi Metropolis generate "30-35" tons "Hospital waste" per day. 4th February 2008The News, Pakistan, 24 December 2007. Hospital waste spreading hepatitis.
Daily Times, Pakistan, 11 Nov 2007. 12 hospitals served notices for poor waste management. more
Dawn, the Internet Edition, Karachi, Pakistan, 5 June 2007. Clinical Waste Incineration Not a Solution. more

Panama

La Estrella, Panamá, 14 April 2011. MINSA arriesga la salud por un negocio. more

Peru

El Regional, Piura, Perú, April 2011. Municipalidad de Piura inaugurará celda de residuos hospitalarios. more
Generacción, Lima, Perú, April 2011. Lima: Lanzan plan de residuos sólidos para hospitales e institutos de salud. more

Philippines

PIA Press Release, Tacloban, Philippines, 5 November 2010. Group in Eastern Visayas Holds Healthcare Waste Management Forum. more
Health Care Without Harm SE-Asia, Manila, Philippines, 26 August 2010. Envi Groups Laud DoH Scrapping of Incinerator Plan. more
PhilStar.com, Philippines, 12 Aug 2010. Group raises alarm over plan to revive incinerators. more
Health Care Without Harm SE-Asia, Philippines, 7 August 2010. Envi-health Group Asks P-Noy to Keep All Hospitals Malinis at Mabango. more
PIA Daily News Reader, Philippines, 5 August 2010. HCWH SEAsia Raises Alarm on Planned Revival of Incinerators. more
Health Care Without Harm SE-Asia, Philippines, 3 August 2010. Envi-health Group Raises Alarm on Planned Revival of Incinerators.
more
Business Mirror, Philippines, 29 Mar 2010. Envi-health Group Raises Alarm on Planned Revival of Incinerators. more
The Philippine Star, Philippine, 23 Mar 2010. Water biggest victim of improper waste management. more
Inquirer.net, Philippines, 7 April 2009. Release P100M for medical waste treatment. more
The Mindanao Daily Mirror, Philippines, 28 March 2009. Hospitals urge DOH to release P100-M fund for health. more
The Seoul Times, Malaysia, 5 Feb 2009. 43 RP Congressmen Sign Debt Cancellation Move. more

Qatar

The Peninsula Qatar, Qatar, 28 February 2011. Guidelines Issued on Hazardous Waste Management. more

Dominican Republic

Listin Diario, República Dominicana, April 2011. República Dominicana: Multarán por mal uso de los residuos. more
El Día, República Dominicana, April 2011. República Dominicana: ADN intima clínicas por manejo residuos. more

Saudi Arabia

Saudigazette.com 11 May 2011. Medical, organic waste threatening Jeddah's environment. more

The Saudi Gazette, Al-Ahsa, Saudi Arabia, March 2011. Fine For Improper Disposal of Medical Waste. more
The Saudi Gazette, Sourat Obaida, Saudi Arabia, February 2011. Drinking Water Contaminated With Hazardous Medical Waste. more
The Saudi Gazette, Jeddah, Saudi Arabia, December 2010. Medical, Organic Waste Threatening Jeddah's Environment. more
The Saudi Gazette Jeddah, Saudi Arabia, November 2010. Unsafe Waste Disposal Poses Threat to Public Health. more

South Africa

News 24, South Africa, 6 May 2011. Firm wants dumping case struck from roll. more
Times Live, South Africa, 9 February 2011. Medical waste: seven in court. more
News24, South Africa, 24 January 2011. Pretoria: Medical waste dumping to be probed. more
News24, South Africa, 30 November 2010. 2A R5m For Dumping Medical Waste. more
Times Live, South Africa, 28 November 2010. Oppenheimers Caught in Medical Waste Scandal. more
Times Live, South Africa, 4 November 2010. Medical Waste Dumps "Clean". more
News24, South Africa, 3 November 2010. Illegal Medical Waste Sites Clean. more
News24, South Africa, 2 November 2010. Green Scorpions to Inspect Medical Waste Site. more
IOL News, South Africa, 22 July 2010. Dead Babies Found in Medical Waste. more
Times Live, South Africa, 21 July 2010. Tiny Boy and Girl Dumped With Medical Waste. more
IOL News7 June 2010. HIV Test Kits Dumped Near School. more
Times Live, South Africa, 3 June 2010. State Medical Waste Clean-up Continues. more
Health24, South Africa, 27 May 2010. Medical Waste discovered at Marianhill. more
Times Live, South Africa, 19 May 2010. Hospitals Behind Illegal Dumping. more
News24, 18 May 2010. Medical Waste Probe in KZN. more
Times Live, South Africa, 12 May 2010. Government to Set Up Own Waste Sites. more
Times Live, South Africa, 18 April 2010. Troubled Wasteman Still in Use. more
GroundWork, South Africa, March 2010. South Africa: Health Care Waste Crisis? What Crisis? more
Times Live. South Africa 9 February 2010. Arrest in Medical Waste Case. more
News24, South Africa, 8 Feb 2010. Medical Waste: Kingpin Held. more
News24, South Africa, 10 December 2009. 20 Tons of Medical Waste Found. more
Times Live, South Africa 10 December 2009. More Medical Waste Found. more
Times Live, South Africa, 8 December 2009. Waste-management Firm Disputes Dumping Charges. more
Times Live, South Africa, 6 December 2009. Wasteman May Have to Close Incinerator. more
News24, South Africa, 2 December 2009. More Medical Waste Dumps Found. more
Times Live, South Africa, 2 December 2009. Another Medical Waste Dump Exposed. more
News24, South Africa 1 December 2009. Waste Head Steps Down. more
Times Live, South Africa 1 December 2009. South Africa: New Twist in Medical Waste Scandal. more
Times Live, South Africa, 30 November 2009. Medical Waste Horror - Group Boss Quits. more
Wasteman Press Release, South Africa, November 2010. Incinerator Facility Questioned but No Concerns on Environment and Health. more
Times Live, South Africa, 29 November 2009. Body parts, Bloody Bandages Buried by the Truckload in Shallow Trenches. more
Times Live, South Africa, 29 November 2009. Medical Waste Company Pursued. more
IOL News, South Africa, 19 February 2004. Baboons get TB as medical waste is dumped. more

Uganda

The New Vision, Uganda, 23 Aug 2010. Gulu Hospital Chokes on Garbage and MedWaste. more

United Arab Emirates

Gulf Today, Ajman, United Arab Emirates, 13 March 2011. Municipality is Focusing on Medical Waste. more
Khaleej Times, ABU DHABI, United Arab Emirates, 7 September 2010. Mounting Medical Waste Poses Health Risk in Capital. more

United Kingdom

BBC News Online 3 June 2011. MRSA: New strain of superbug found in cows. more
The Telegraph, UK, 23 September 2009. 'Illegal waste' shipped to Brazil. more

United States of America

NJ.com, 10 May 2011. Docs who dump medical waste would lose licenses under bill proposal. more
Star Advertiser, Hawaii, 18 January 2011. Medical Waste Spreads Down Coast. more
Bloomberg, US, 11 January 2011. Hospital Joins Practice Green Health Project to Reduce OR Waste. more
WPXI.com, USA, 22 October 2010. Medical Waste Found Dumped In Area Neighborhood. more
Reuters US, USA, October 2010. More than 55 Hospitals Enlist in Green OR Movement. more
AllGovNews, USA, 12 July 2010. Medical Waste a Growing Problem in Disposable Era. more
NJ.com, USA, 04 Sep 2009. More medical waste washes up on Long Beach Island. more

Vietnam

Vietnam News, Vietnam, 6 November 2010. Hospitals Lack Waste Treatment Facilities. more