Health Care Waste Management in Kyrgyz Hospitals

14 October 2013

External Project Review

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EXTERNAL PROJECT REVIEW

CONTENTS

EXECUTIVE SUMMARY i

LIST OF ABBREVIATIONS AND ACRONYMS iv

1. INTRODUCTION 1

2. OBJECTIVE OF THE EVALUATION 1

3. EVALUATION METHODOLOGY 1

3.1 Evaluation Process 1

3.2 Method of Evaluation Relative to the Log Frame Outcome and Outputs.............................. 2

3.3 Methodology for the Evaluation of the HCWM Model 3

3.4 Scoring System for Relevance, Efficiency, Effectiveness, Impact, and Sustainability of the Overall Project 4

4. DESCRIPTION OF THE HCWM MODEL 5

5. EVALUATION OF THE OUTCOME, OUTPUTS, AND HCWM MODEL 9

5.1 Comparison with the Outcome and Outputs in the Log Frame 9

5.2 Assessment of the HCWM Model 10

5.2.1 QUALITATIVE ASSESSMENT OF HCWM COMPONENTS...10

5.2.2 ASSESSMENT OF THE TREATMENT METHOD..12

5.2.3 QUANTITATIVE ASSESSMENT USING THE I-RAT..14

5.2.4 SPECIFIC ASSESSMENT OF THE SELECTED HOSPITALS AND ADDITIONAL OBSERVATIONS...15

5.3 Assessment of Administration and Financing 17

6. DESCRIPTION OF THE ACHIEVED RESULTS 18

7. EVALUATION OF RELEVANCE, EFFICIENCY, EFFECTIVENESS, IMPACT, AND SUSTAINABILITY.. 22

8. CONCLUSIONS 24

9. SUMMARY OF RECOMMENDATIONS 25

Recommendation to SRC for Improving the HCWM Model before the End of the Project...................25

Recommendations to the Ministry of Health for the Immediate Future Related to the HCWM Model 25
Recommendations to the Ministry of Health for the Long-Term to Address Issues beyond the Scope of the Project 26

ANNEX A **30**
Mission Program 30

ANNEX B **32**
List of Persons Interviewed During the Meetings 32
List of Documents Reviewed 33

ANNEX C **35**
List of Hospitals in the Kyrgyz Republic with HCWM Systems 35

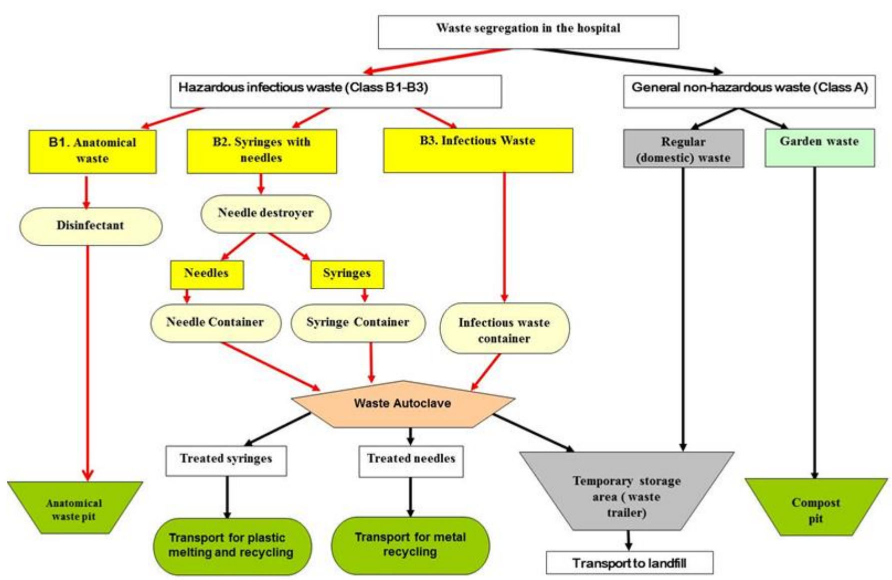
ANNEX D **39**
Data from the Modified UNDP GEF-WHO-HCWH Rapid Assessment Tool I-RAT 39

ANNEX E **47**
Suggested Content of an Informational Brochure and Technical Paper on the HCWM Model 47
Procedure for Donning and Removing PPE 47
Suggestions on Enhancing the Decomposition of Anatomical Waste in the Waste Pits 49
Recommendations Related to Pressure Cookers as Autoclaves for Small Health Facilities 52
Recommendations on Alkaline Hydrolysis Technology for Centralized Treatment of Anatomical Waste in Bishkek 54
Suggestions Related to Hazardous Chemical Wastes in Hospitals 57
Pharmaceutical waste 57
Cytotoxic waste 58
Chemical waste 58
Radioactive waste 59
Mercury 61

EXECUTIVE SUMMARY

The Swiss Agency for Development and Cooperation (SDC) mandated the Swiss Red Cross (SRC) to develop a health care waste management (HCWM) model and to replicate it in rural hospitals in the Kyrgyz Republic. This report presents the results of an independent evaluation of the project. The method of evaluation consisted of a review of documents, site visits to six hospitals, and interviews with local and national stakeholders. Assessments were made relative to the expected outcome and outputs of the project as well as a qualitative assessment of each component of HCWM, a quantitative assessment using the UNDP-WHO Individualized Rapid Assessment Tool (I-RAT), and a scoring system to evaluate relevance, efficiency, effectiveness, impact, and sustainability.

The Swiss Red Cross in collaboration with the Republican Center for Infection Control developed a HCWM model that uses needle destroyers, autoclavable enamel-coated metal containers, and an autoclave as the treatment technology. Infectious wastes are segregated at the point of generation in the enamel containers. Sharps wastes from injections are first destroyed using mechanical needle cutters or destroyers immediately after an injection. The needle destroyer cuts the needle at the hub, allowing the needle to fall into an enclosed cup. The plastic part is then segregated by being placing in a separate enamel container. All enamel containers are labeled with the international biohazard symbol, the type of waste, the department that produced the waste, and a number. Laminated posters are placed in strategic areas to remind health workers of proper segregation procedures. When the enamel containers are 3/4th full or at least every day, the enamel containers are covered with a lid affixed by a clip and transported to the autoclave room. When the needle destroyer cup is 3/4th full, it is closed and also brought to the autoclave room where the needles are carefully transferred to an enamel container. The infectious wastes including needles and plastic syringes are treated in the autoclave. After treatment, the plastic syringe parts are stored in sacks and sold to recyclers for re-melting into other products. In hospitals near metal recyclers, the treated needles are stored in metal drums and sold to the recyclers for melting. The rest of the treated waste is placed in plastic bags and stored in trailers along with regular wastes which are subsequently hauled to a landfill. The trailer is under a shed next to cement pits for anatomical waste, and both the trailer and the pits are surrounded by a fence with a locked gate and warning sign. Anatomical and placenta wastes are collected in hard plastic or enamel containers, disinfected with calcium hypochlorite, and then deposited in the secure pits to decompose. Empty glass ampoules and vials are collected in boxes and recycled where possible. Vegetable and garden wastes are placed in compost pits. The overall HCWM model is summarized in the schematic below.



The mechanical needle destroyer is of good quality with a breakage rate of only 2% in seven years based on data from one hospital. The autoclave is a gravity-displacement Russian-built VK-75 autoclave which is affordable, familiar to the staff, compact, durable, and well-constructed with an internal chamber made of stainless steel and an internal boiler. One hospital operates a 29-year old VK-75 autoclave that was refurbished in 2006 and seems to be excellent condition. Equipment life of the autoclave is expected to be 20 to 30 years with good maintenance. The autoclave treatment process involves multiple pressure pulses wherein steam is flushed through a porous metal filter. These steam flushing cycles remove air and result in good steam penetration as shown by tests wherein temperature was measured by thermocouples buried in the waste. The autoclave process exceeds the international STAATT criteria by ten times or higher as shown by microbiological tests using *Geobacillus stearothermophilus* spores.

As part of the system, each hospital has a Safety & Quality Committee that oversees HCWM and related activities in the facility. The committee periodically reviews HCWM procedures, develops the budget, monitors activities, and implements training workshops. The infection control specialist and epidemiology specialist function as HCWM advocates in the hospital. They report a change in the mindset of health workers and a greater appreciation of the hazards of health care waste and the importance of HCWM among the staff.

The HCWM model has all the major components of a good system: waste minimization (including inventory control of medicines, reusable containers, recycling, and composting), segregation, durable leak-proof containers, labeling and signage, safe collection and transport, use of personal protection equipment, emergency kits for accidental exposure to infectious waste, proper storage of waste, safe management of sharps and anatomical wastes, clear hospital policies, written HCWM guidelines, a committee and advocates to promote HCWM, regular training, documentation, record-keeping, monitoring and continuous improvement, and the allocation of human and financial resources.

The I-RAT scores of the six hospitals range from 92 to 97 out of a total of 100 points. These are high scores compared to those of many low- and middle-income countries. The HCWM system developed in Kyrgyzstan is outstanding and can serve as a model for other countries. Because of the project, Kyrgyzstan is well ahead of many developing countries in its management of health care waste.

By installing 119 HCWM systems and sharing the treatment systems with Family Medical Centers, dental facilities, private clinics and some specialized hospitals in the area, the project has effectively covered all hospitals with 25 beds or greater (except for a few specialized hospitals) in all parts of the country except for Bishkek, corresponding to 67% of all hospital beds in Kyrgyzstan. The project was well conceived, designed, planned, and implemented by SRC. The cost per capita of the project amounts to 0.61 USD per covered population, about a third to a half of the cost per capita of similar projects in other countries.

While it is too early to determine the impact of the HCWM system on hospital-acquired infections and infection control in general, data from one hospital already shows a significant decrease in needle-stick injuries and cuts reported by health workers. The HCWM system also decreases the exposure of hospital staff to chemical disinfectants and makes their work easier by eliminating the need to prepare many batches of sodium hypochlorite solutions as required under the old system. This means that health providers can spend more time with their patients—a major advantage of the new HCWM system from the perspective of the nursing staff. The new system also ends the burning of waste and in doing so, eliminates the problem of staff exposure to toxic smoke and complaints by neighbors.

Most hospital directors have found that the new HCWM system reduces their costs and generates income. A survey of 30 hospitals shows an average annual cost savings of 50858 KGS due to the HCWM system or

33% savings compared to their costs before the project. Moreover, hospitals generate revenues from the sale of the recycled plastics and metals, amounting to 29140 KGS in the case of one hospital. On average, the HCWM costs account for 0.68% of the operating budgets of the hospitals, making HCWM affordable for the hospitals. An indication of the degree of ownership of the project by the beneficiaries is the co-financing in cash and in kind provided by the hospitals. As project funding has ended, the hospitals are now covering the costs of maintaining their HCWM systems. Many have entered into cost-sharing arrangements with other facilities thereby maximizing the use of the treatment system, expanding its coverage, and enhancing sustainability.

Specific evaluations of the six hospitals found some minor inconsistencies and recommendations are made to address them. Recommendations for the near future are also presented to the Ministry of Health regarding possible refinements of the HCWM model. Long-term recommendations and suggestions are offered to cover areas that were outside the scope of the project, such as the replication of the model with some changes in small rural health posts and in the city of Bishkek, and the management of hazardous chemical waste, pharmaceutical and cytotoxic waste, radioactive, and mercury wastes from hospitals.

The project has yielded indirect benefits including a national decree by the Ministry of Health which incorporated input developed through the project and new guidelines by the Medical Accreditation Commission that are based on guidelines developed through the project. Several hospitals on their own have hosted HCWM trainings and tours of their HCWM systems for other hospitals. By doing so, they are helping to raise awareness of the importance of HCWM among the hospitals not covered by the project and even hospitals outside the country.

The project has fulfilled its stated objectives and achieved the expected outcome and outputs. The project has remained relevant, was highly effective and efficient, resulted in direct and indirect benefits to the target beneficiaries and to the country, and has a high likelihood of being sustained well after project termination. The development of an exemplary HCWM system by the project and its expansion throughout most of Kyrgyzstan has enhanced the protection of patients, health workers, the community, and the environment from the hazards of health care waste. The project serves as a good model for other developing countries.

LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired immunodeficiency syndrome
cm	centimeter
C:N	carbon-to-nitrogen ratio
FGP	Family Group Physicians
FMC	Family Medical Center
FOP	Rural Health Post
GEF	Global Environment Facility
HCWM	Health care waste management
IC	infection control
I-RAT	Individualized Rapid Assessment Tool
kg	kilogram
kPa	kilopascal
KSHRSP	Kyrgyz-Swiss Health Reform Support Project
Log Frame	Logical Framework
m	meters
mm	millimeters
MOH	Ministry of Health
PPE	Personal protection equipment
Psig	pounds per square inch (gauge pressure)
RCIC	Republican Center for Infection Control
SDC	Swiss Agency for Development and Cooperation
SES	Sanitary and Epidemiologic Service (now called the State Center for Sanitary and Epidemiologic Control)
SRC	Swiss Red Cross
STAATT	State and Territorial Association on Alternative Treatment Technologies (now known as ISTAATT or International Society on Analytical Assessment of Treatment Technologies)
TB	Tuberculosis
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
VK-75	Autoclave model manufactured by Tyumen Plant of Medical Equipment and Tools, Russia
WHO	World Health Organization

1. INTRODUCTION

The Swiss Government has been supporting Kyrgyzstan's health sector reform since 1999. The Swiss Agency for Development and Cooperation (SDC) mandated the Swiss Red Cross (SRC) to implement the Kyrgyz-Swiss Health Reform Support Project (KSHRSP). A thorough assessment of the health care situation in the country identified the need for improving the hospital infrastructure in the rural areas as an immediate priority.

Recognizing the problems associated with improper health care waste management (HCWM), the SDC approved an expansion of the work to include the development of HCWM models at hospitals in Naryn and Talas oblasts in collaboration with the Republican Center for Infection Control (RCIC). The model was adopted by the Kyrgyz Ministry of Health (MOH) and was replicated in more hospitals in Issyk-Kul and Chui oblasts in 2010. A subsequent phase of the project expanded the HCWM model throughout the country except for the city of Bishkek. The Swiss Embassy and SDC have commissioned this evaluation of the HCWM model and the impact of the project in the country.

2. OBJECTIVE OF THE EVALUATION

The objective of the evaluation is to assess and document the impact of the HCWM model nationwide. In particular, the evaluation entails:

- Assessing the HCWM model with regards to its effectiveness and efficiency in solving medical waste issues at hospitals in Kyrgyzstan
- Assessing the achievements of the HCWM project in relation to the project objectives defined in the Project Document (outcome 1).

3. EVALUATION METHODOLOGY

3.1 Evaluation Process

The evaluation process involved a review of documents, site visits to six hospitals, and interviews with key stakeholders at the national and local levels. The mission schedule is shown in Annex A. The documents reviewed and the personnel interviewed are listed in Annex B.

Each hospital visit consisted of the following:

- Initial meeting with the hospital director to explain the purpose of the visit, the process, and areas of the hospital to see;
- Walk-through, observation, and photo-documentation of: several locations where health care waste was generated and where needle destroyers were used, types of containers used, markings or labels on containers, locations of containers, random check of the contents of containers to assess waste segregation, types of personal protection equipment (PPE) used for handling health care waste, emergency kits (used in case of waste spills, needle-stick injuries, or exposure to blood and body fluids), locations of HCWM posters, method of transport of infectious and sharps waste, typical route for transport of infectious waste, storage area for infectious waste, warning signs in the storage area, waste treatment room, types of disinfectants used for decontaminating containers, trailer used for regular (non-infectious) waste, pits for anatomical waste, storage area for recyclable treated waste, and the composting area; evaluation of the treatment technology;

- Interviews of medical or nursing staff regarding procedures on segregation, collection, and transport of health care waste; interviews of technical staff regarding the waste treatment process;
- Completion of the Individualized-Rapid Assessment Tool (I-RAT)[1];
- Final interview and request for additional information from the key personnel in charge of HCWM.

The six hospitals that were visited, shown in the list and map below, range from 70 to 452 beds:

1. Kara-Suu Pediatric Hospital , Kara-Suu City, Osh Oblast
2. Suzak Territorial Hospital, Suzak District, Jalal-Abad Oblast
3. Naryn Oblast Hospital, Naryn District, Naryn Oblast
4. Kochkor Territorial Hospital, Kochkor District, Naryn Oblast
5. Balykchy City Territorial Hospital, Balykchy City, Issyk-Kul Oblast
6. Issyk-Kyl Territorial Hospital, Cholpon-Ata City, Issyk-Kul Oblast.

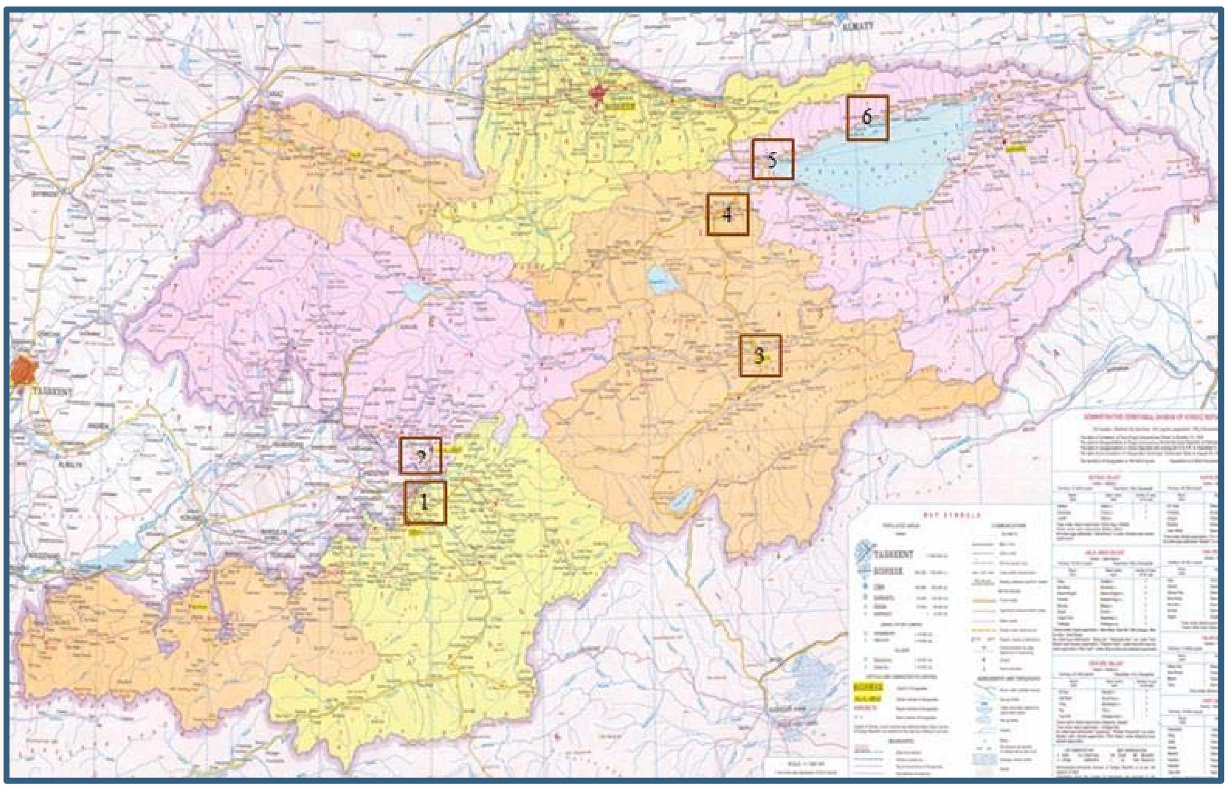


Figure 3.1 Map showing the locations of the hospitals visited during the evaluation

3.2 Method of Evaluation Relative to the Log Frame Outcome and Outputs

One of the specific objectives of the evaluation is to compare the achievements of the project with Outcome 1 of the Logical Framework of the Project Document (see Table 3.1). The key indicators are used to evaluate the achievements in comparison with the outcome and outputs.

[1] Assessment tool developed by the United Nations Development Programme (UNDP) and the World Health Organization (WHO) under the UNDP GEF project on global health care waste

Table 3.1 Logical Framework Related to Outcome 1

Hierarchy of Objectives Strategy of Intervention	Key Indicators	Data Sources Means of Verification
Outcome 1. All hospitals of the covered regions have functioning HCWM streams	No waste lying around on campuses	On-site visits
Output 1. Waste management equipment is in place	Existence of equipment in all hospitals	On-site visits
Output 2. Personnel capable of utilizing and managing the whole system.	Safe performance of routine operational procedures.	On-site visits

3.3 Methodology for the Evaluation of the HCWM Model

Two methods are used evaluate the HCWM model. The first method is a qualitative assessment of each of the key components that comprise a good HCWM system. The second method is a quantitative assessment using a UNDP-WHO rapid assessment tool.

A good health care waste management system protects the patients, health workers, the community, and the environment from the hazards of health care waste. Such a system must have the following components: waste minimization, segregation, use of appropriate containers, labeling or color-coding of containers, posters on segregation, safe collection and transport of waste, health and safety practices including the use of PPE and availability of spill kits, proper storage, signs to restrict access to infectious waste, effective treatment or waste, safe management of sharps waste, safe management of other hazardous wastes (microbiological waste, anatomical waste, chemical waste, pharmaceutical and cytotoxic waste, radioactive waste), and proper disposal of non-risk waste. In addition to these practices and technologies, the health care waste management system requires institutionalization through policies, organization, and processes. This means that HCWM also entails facility-level policies, written guidelines and plans, an active health care waste management committee, HCWM advocates or champions among the staff, regular training, documentation and record-keeping, a system of monitoring and continuous improvement, and human and financial resources to ensure sustainability. The HCWM model in Kyrgyzstan is assessed for each of these key components.

Special attention is given to the treatment method, an important part of a HCWM system. In keeping with the WHO policy paper on health care waste management, the treatment method should be environmentally sound, support the Stockholm Convention on Persistent Organic Pollutants and the Basel Convention on Hazardous Waste, reduce exposure to toxic pollutants, and promote non-incineration technologies.[2] Non-incineration methods should meet the STAATT microbial inactivation efficacy requirement, namely, inactivation of G. *stearothermophilus* spores or B. *atrophaeus* spores at a 4 Log_{10} reduction or greater.

The UNDP-WHO Individualized Rapid Assessment Tool (I-RAT) is used to rank the HCWM systems of the six hospitals. The I-RAT is an Excel-based tool for obtaining a quick indication of the level of health care waste management at an individual healthcare facility. It is comprised of a series of questions that can be answered by "yes" or "no" with each question assigned a weighting factor depending on their importance in HCWM. The higher the final score, the better. The highest score is 100 points. The I-RAT was modified to fit the situation in Kyrgyzstan in the following ways: (1) Since the government does not require a color-coding scheme for waste containers, the use of container labels and markings is accepted in lieu of color coding for Questions

[2] "Safe health-care waste management," policy paper, World Health Organization, Geneva, Switzerland, August 2004.

38-39; (2) Since the hospitals are relatively small and the containers are closed during transport, a wheeled cart for transporting infectious waste is not necessary for Question 43; and (3) Question 62 is replaced with a question regarding safe burial of anatomical waste in lined pits.

3.4 Scoring System for Relevance, Efficiency, Effectiveness, Impact, and Sustainability of the Overall Project

In addition to evaluating each component of the HCWM model, assessing HCWM using the I-RAT and comparing the achievements to the Log Frame analysis, the evaluation also looks at relevance, efficiency, effectiveness, impact, and sustainability of the project as a whole. A simple scoring system is used to evaluate these five topics. Each topic accounts for 20 points, giving a maximum total of 100 points. The topics are concretized by means of subheadings which are used to rate the project. Each subheading is scored from 0 to 1 but is assigned a weighting factor depending on its relative importance.

The topics, subheadings, and their respective weighting factors are given in Table 3.2 below.

Table 3.2 Weighting Factors for Relevance, Efficiency, Effectiveness, Impact and Sustainability Subheadings

Topic/Subheading	Score
Relevance	
Relevance at conceptualization	4
Relevance today	4
Quality of design	4
Quality of intervention	4
Complementarity with other projects	4
Efficiency	
Efficiency of administration	4
Cost efficiency	4
Timeliness	4
Involvement of beneficiaries	4
Comparison to alternatives	4
Effectiveness	
Attainment of primary objective	8
Attainment of output 1	6
Attainment of output 2	6
Impact	
Impact on target group	8
Contribution to overall objectives	8
Indirect impacts	4
Sustainability	
Financing	6
Capacity building	6
Policy, assignment of roles & responsibilities	6
Institutional culture	2

4. DESCRIPTION OF THE HCWM MODEL

The HCWM model developed through the collaboration of the Swiss Red Cross and the Republican Center for Infection Control was initiated in Naryn Oblast Hospital and other nearby hospitals. A process of testing and improvement was undertaken with the active participation of hospital staff and other stakeholders. It is noteworthy that personnel in all six hospitals commended the collegial and interactive manner in which the implementation and refinement of the model was done. The ultimate result is the health care waste management model that is depicted in the schematic in Figure 4.1.

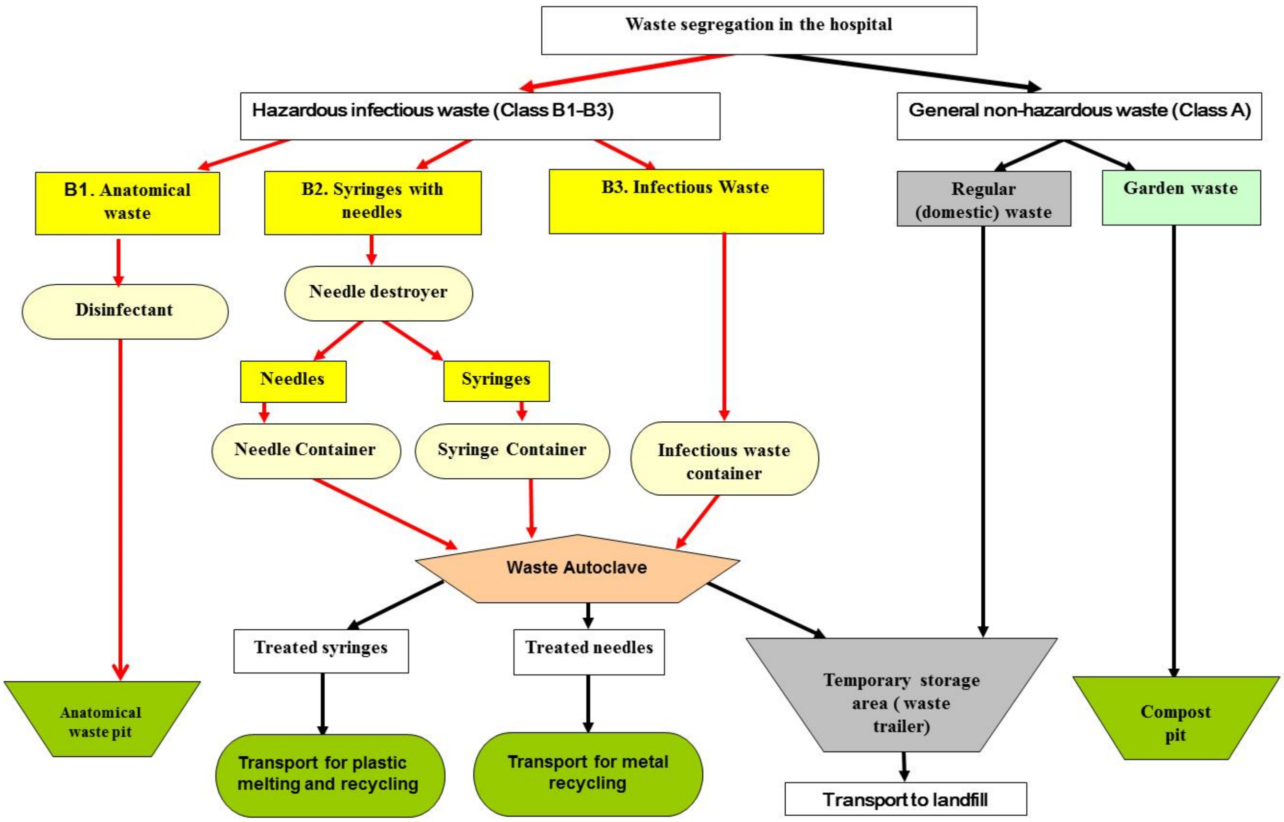


Figure 4.1 Schematic of the health care waste management model

Figure 4.2 Enamel container

Segregation of infectious, sharps, and non-infectious wastes is practiced at the point of generation. Leak-proof enamel-coated metal containers (10 liter buckets) with carrying handles and enamel lids, as shown in Figure 4.2, are used to contain and segregate needle-less syringe waste and the other infectious wastes such as potentially contaminated gloves, cotton swabs, bandages, gauze, etc. The sides and the lids of the enamel containers have the international biohazard symbol and are labeled with the type of waste, hospital department, and container number. Binder clips are used to fasten the lids in place during transport.

Non-infectious sharps wastes such as empty glass vials, empty medicine bottles, and empty ampoules are collected in cardboard boxes. Other non-infectious waste is collected in black plastic bags, which are placed inside hard plastic containers or cardboard boxes.

The enamel containers along with non-infectious waste containers are generally placed side-by-side on the floor or on the bottom shelf of a table or trolley. Segregation posters are placed on the wall above or near the containers as shown in Figure 4.3.

Procedure rooms are equipped with needle destroyers (Figure 4.4) generally within an arm's length of the health worker. Immediately after giving an injection, the nurse or doctor inserts the needle into the needle destroyer and pulls down the handle to cut the needle at the hub. The needle falls into the hard plastic container of the needle destroyer while the plastic syringe is placed in the enamel container designated for the needle-less syringes. The clean packaging of the syringe is placed in the plastic bag for non-infectious waste. Empty vials or ampoules are considered non-infectious and are collected in cardboard boxes. A journal or register is kept in each procedure room to document the date, type and volume of the syringe(s) used, number of injections, patient name, etc.

Figure 4.3 Containers and segregation poster

Figure 4.4 Needle destroyer

The outside surfaces of needle destroyers are wiped with 2% Tetramin disinfectant daily. Once a week, they are dismantled, soaked in 2% Tetramin for 10 minutes, then oiled and reassembled.

Each procedure room has personal protection equipment (PPE), an emergency kit, and a register to record needle-stick injuries, exposure to blood and other accidents, including information on what occurred, who was involved, and what actions were taken after the accident.

Figure 4.5 PPE worn when transporting waste

Waste containers are removed whenever the containers are $3/4^{th}$ full or at least once a day (twice a day in some hospitals). The lid is first secured to the container using two binder clips. The staff person responsible for transporting the waste puts on hard shoes or boots, apron, face mask, gloves, and cap (see Figure 4.5). The containers are transported to the waste treatment room. Charts are posted in the procedure rooms and the main hallways showing the routing of the waste (Figure 4.6).

Figure 4.6 Waste flow chart

A typical layout of the waste treatment room is shown in Figure 4.7 wherein dirty and clean areas are kept separate to avoid cross-contamination.

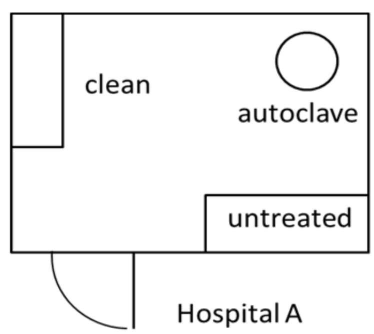


Figure 4.7 Sample layout of a treatment room

A sign prohibiting access to unauthorized personnel is mounted above the door, as

Figure 4.8 Sign at the entrance to the autoclave room

shown in Figure 4.8.

In the waste treatment room, the staff person hands over the infectious waste containers to the technician who then weighs the containers and records the date, content, weight, number of containers, staff person's name, department, and any comments. The containers are then temporarily stored on shelves that are marked "dirty". Departments have two sets of containers such that one is in use while the other is being treated. The plastic needle containers from the needle destroyers are not autoclaved. Instead, the needles are carefully transferred to an enamel container for autoclaving, and the plastic containers are soaked in Tetramin or Lysoformin disinfectant solution for an hour before being left to dry on shelves marked "clean" along with empty containers that have already been autoclaved (Figure 4.9). Other sharps in plastic containers (e.g., blades, surgical knives, etc.) are also transferred to enamel containers for autoclaving.

Figure 4.9 Storage for clean containers

Figure 4.10 VK-75 autoclave

Treatment is done using a Russian-made VK-75 vertical gravity-displacement autoclave (400 mm diameter x 630 mm chamber) with a 6 kW external boiler underneath (Figure 4.10). The technician first checks the water level in the boiler and adds distilled water if necessary. Using PPE, the technician puts one "dirty" container at the bottom of the chamber. The container lid is removed and placed alongside the container with the binder clips attached to the handle. A wooden frame is then positioned atop the first container and a second "dirty" container is placed above the wood frame with its lid along the side and the binder clips on the handle. The wooden frame acts as a separator by leaving a gap between the two containers to allow the penetration of steam into the bottom container. Color-changing Class 1 indicators (dots) are placed on the container and/or in open glass vials or ampoules on top of the waste. The autoclave door is then closed. After checking the valves, the technician turns on the autoclave.

The treatment cycle is as follows: Steam is built up in the steam generator (boiler) until the pressure reaches 1.5 bar (150 kPa). The steam is then flushed through the autoclave for five minutes as the air-steam mixture is released through a porous metal filter to the outside. With the release valve shut, steam is allowed to accumulate in the chamber until the chamber pressure reaches 1.5 bar and then it is released through the filter until the pressure reaches atmospheric pressure (0 bar). This pressure pulse is repeated for yet another time, after which steam is again introduced until a pressure of 2.2 bar (220 kPa) is achieved, corresponding to temperatures in the waste of about 131-133^{o}C. The pressure is kept between 2.0 to 2.2 bar (200-220 kPa) for 10 minutes before the steam is finally released. After the pressure is down to 0 bar, the technician waits for 2-3 minutes to allow the autoclave to cool then opens the door and removes the treated waste.

An autoclave journal is used to record the date, waste content, number of containers, department, starting time of the autoclave cycle, completion time of the autoclave cycle, pressure and temperature, results of the Class 1 indicators (the dots are affixed to the journal as evidence of treatment; see Figure 4.11), and the technician's signature.

Figure 4.11 Autoclave journal

Figure 4.12 Drums of treated needles for recycling

Treated needles are stored in metal drums for recycling (Figure 4.12). Treated needle-less syringes are placed in large sacks (Figure 4.13), stored, and later picked up for recycling. Other treated wastes are placed in plastic bags and added to regular (domestic) waste in the trailer.

In maternity wards, hard plastic containers are used to collect placenta. Similarly, anatomical wastes from surgery are collected in plastic or enamel containers. (Plastic containers resist the corrosive effects of hypochlorite better.) Calcium hypochlorite disinfectant powder is placed on placenta or anatomical wastes at a ratio of 1 kg $Ca(OCl)_2$: 5 kg of waste. The lid is placed on the container. After an hour, the lid is secured with binder clips and transported to the pit.

Figure 4.13 Sacks of treated syringes for recycling

Figure 4.14 Pits for anatomical waste

The pits are fully enclosed cement structures constructed in three sections, with each section measuring 2m x 2m x 2m (see Figure 4.14). A small opening with a door is found at the center of each section. The staff person opens the door and dumps the disinfected placenta or anatomical wastes into the pit. In one hospital, it has taken seven years for one pit section to be 3/4th full.

Figure 4.16 Fenced area for trailer and anatomical pit

In each hospital, the pit for anatomical waste is located adjacent to the trailer (Figure 4.15) used for storing regular (domestic) waste. The trailer is under a covered shed. For large trailers, metal stairs are used to make it easier for the worker to deposit the waste bags into the trailer. Both the anatomical waste pits and the covered shed are surrounded by a wire fence (Figure 4.16) with padlocked gates to restrict access and prevent theft of the trailer. A warning sign is posted on the fence. When full, the trailer is hitched to a vehicle and taken to the landfill where the waste is deposited.

Figure 4.17 Compost area

Figure 4.15 Trailer for regular waste

Each hospital also has a composting area (Figure 4.17) comprised of two seasonal pits. Each compost pit is 2 m x 2 m x 1.5 to 2 m deep. The bottom layer has vegetable wastes, stems, and large sticks to create air pockets for aeration. The second layer has smaller items such as grass, leaves, and other plant waste. The third layer is soil mixed with manure, ash, and 5-10 kg of compost from the previous season. Water is added to keep the waste moist and speed up decomposition. Twice during the first two months, the compost is turned and sprayed with water. At the end of the season, the pit is covered with 4-5 cm of soil. Pipes with holes are inserted vertically in different parts of the compost area to improve aeration. While that section is allowed to decompose to form organic compost, the other section is used during the next season for garden waste. The rich compost is later used as a fertilizer and soil conditioner. The compost area is surrounded by a wire fence.

In general, copies of MOH Decree 59, the hospital director's policy introducing the HCWM system, standard operating procedures for autoclave operation, hand hygiene, procedures for emergencies, and various other related policies and procedures are posted on walls. Each hospital has a Safety & Quality Committee whose responsibilities include HCWM. The work of the committee of Hospital C, for instance, is documented in their procedure manual and meeting agenda, which include monitoring, review of the HCWM budget and financial plan, review of procedures related to HCWM, checks on segregation and transport, and receipt of waste by the landfill. Members of the committee of Hospital D do weekly random walk-throughs to check on procedures. Other hospitals conduct audits twice a year. The infection control and epidemiology specialists have functioned as HCWM advocates in the hospitals.

All new staff is trained and hospitals have periodic trainings which are documented. For example, Hospital B organizes trainings every four months. All six hospitals have reported a change in the mindset of workers, resulting in a greater recognition of the hazards of health care waste. Autoclave technicians receive special training and are given certifications. The results of the treatment process are permanently recorded in journals along with proof of treatment in the form of color-changing indicators and the signature of the autoclave technician. These journals are kept in the autoclave room. When the autoclave is first installed, the hospital is provided with an initial set of spare parts including gaskets and extra heating elements. After two years of operation, the autoclave is tested and certified annually by a national medical technology institute. The autoclave certification pertains to the accuracy of pressure measurements and the results of a pressure vessel test.

Hospitals have developed various forms of simple cost-sharing arrangements to allow Family Medical Centers, dentists, private clinics, and other health facilities within the campus or nearby to make use of the treatment system. In some cases, the salary of the autoclave technician is shared by several facilities. Other facilities share the costs depending on the amount of waste they generate. Smaller facilities may pay for the cost of transporting the waste or the cost of electricity used by the autoclave. These arrangements maximize the use of the treatment systems in each region.

5. EVALUATION OF THE OUTCOME, OUTPUTS, AND HCWM MODEL

5.1 Comparison with the Outcome and Outputs in the Log Frame

The evaluation of the outcome and outputs as defined in the Logical Framework of the Project Document is based on site visits to the six hospitals. The evaluation assumes that those hospitals are representative of all hospitals under the project. The evaluation is presented in column 3 of Table 5.1.

Table 5.1 Evaluation of Outcome and Outputs in the Log Frame

Hierarchy of Objectives Strategy of Intervention	Key Indicators	Evaluation
Outcome 1. All hospitals of the covered regions have functioning HCWM streams	No waste lying around on campuses	The hospitals had functioning HCWM systems as described in Section 4. Moreover, a visual inspection found the hospital premises to be generally clean, with no waste lying around on campuses.

Output 1. Waste management equipment is in place	Existence of equipment in all hospitals	The hospitals had needle destroyers, enamel containers, autoclaves and accessories, waste storage and autoclave treatment rooms, anatomical waste pits, trailers, and PPE. All equipment was in use and in good condition.
Output 2. Personnel capable of utilizing and managing the whole system.	Safe performance of routine operational procedures.	Personnel at all levels were trained. Personnel were capable of all the routine procedures: waste minimization, needle destruction, waste segregation, use of PPE, as well as waste collection, transport, storage, treatment and disposal. A Safety & Quality Committee managed the HCWM system in the hospitals. A system of documentation, periodic training, monitoring, and continuous improvement was institutionalized in the hospitals.

5.2 Assessment of the HCWM Model

5.2.1 QUALITATIVE ASSESSMENT OF HCWM COMPONENTS

An assessment of the key components of the HCWM model in Kyrgyzstan is presented in Table 5.2 based on the six hospitals visited during the mission. The check marks signify a positive assessment.

Table 5.2 Qualitative assessment of key components of the HCWM Model

KEY COMPONENTS	Assessment	NOTES
Waste minimization	✓	Recovery, re-melting and recycling of plastics and metals from sterilized syringes; composting of garden waste; reduction of disinfectant use (due to autoclaving); inventory control of pharmaceuticals; some hospitals reduce unnecessary injections
Waste segregation	✓	Segregation of sharps waste, anatomical waste, other infectious wastes, and general (non-risk) waste
Appropriate containers	✓	Durable (over 7 years life span), leak-proof, puncture-proof containers, capable of being closed during transport, easily cleaned, autoclavable (reusable), available locally, affordable
Container labeling and color-coding	½✓	Containers labeled with biohazard symbol, type of waste, department, and number; no color coding scheme
Segregation posters	✓	Laminated posters on waste segregation placed in procedure rooms, posters on routing of waste stream placed in hallways
Safe collection	✓	Infectious waste containers removed when 3/4th full or at least once a day
Safe transport in the facility	✓	Container lids secured during transport, use of PPE (heavy gloves, boots, apron, and face mask) during transport

Personal protection equipment	✓	PPE available to medical and technical staff; PPE used by the staff
Waste spill kits	✓	Emergency kits and PPE available in all procedure and autoclave rooms
Other health & safety practices	✓	Vaccination of all health workers, emergency kits include post-exposure procedures, hand washing posters in most rooms
Proper storage	✓	Containers stored on shelves in treatment room with dirty and clean containers separated; impermeable and easy to clean floors, water and sink available for washing, easy access of storage room to staff, sign to restrict public access, room protected from weather, good lighting, PPE and emergency kit available, local exhaust ventilation, cleaned once a week
Signage	✓	Warning signs posted on the autoclave room door and on gate to the anatomical waste pits and regular waste trailers
Environmentally sound treatment	✓	Durable and readily available autoclave technology using a process cycle that has been validated to exceed the international STAATT microbial inactivation criteria by more than a factor of 10 (see Section 5.2.2)
Sharps waste management	✓	Use of affordable needle destroyers that are durable (over 7 years life span) and some are locally made; segregation and autoclave treatment of needles and syringes
Microbiological waste management	-	None of the hospitals visited generates microbiological lab waste
Anatomical waste management	✓	Placenta, surgical and other pathological wastes are segregated, chemically disinfected, and disposed in cement pits that prevent contamination of groundwater
Chemical waste management	✗	No chemical waste management plans, spent disinfectants are discarded in the drain, no procedures for mercury waste
Pharmaceutical/cytotoxic waste management	-	None of the hospitals visited generates cytotoxic waste; no pharmaceutical waste due to good inventory control
Radioactive waste management	-	None of the hospitals visited generates radioactive waste
Disposal of non-risk waste	✓	Regular (domestic) waste collected in black plastic bags and stored in a trailer parked under a shed with a locked fence; trailer periodically brought to municipal landfill; garden waste is collected and composted
Facility-level policies	✓	Facility policies specify roles and responsibilities of staff related to HCWM; copies of National Decrees 59 and guidelines are also available
Written HCWM guidelines/plans	✓	Written procedures related to HCWM and autoclave treatment are in procedure rooms and autoclave treatment rooms

HCWM committee	✓	Each hospital has a Safety & Quality Committee that has responsibility for HCWM, infection control, and related fields
HCWM advocates/champions	✓	The infection control nurse, epidemiologist and/or head nurse act as advocates for HCWM
Regular training	✓	After initial training, training is conducted periodically (annually or in some cases every 4 months); training given to new staff; training covers the major components of HCWM; training workshops and attendees are documented
Documentation/record-keeping	✓	Journals and registers provide a daily record of syringe and medication usage, sources and weights of waste treated, autoclave usage, and accidents involving needle-sticks and blood exposures; procedure manuals are available
Monitoring & continuous improvement	✓	Safety & Quality Committee members conduct a periodic walk-through of the facility to identify issues and improve HCWM
Allocation of human resources	✓	Hospitals have full-time or part-time paid staff for HCWM including autoclave technicians
Allocation of financial resources	✓	In hospitals where project funding has ended, the hospitals have budgeted funds for HCWM; HCWM model results in significant cost savings compared to past practices in the six hospitals; recycling of plastics and metals provides additional revenues.

The only subject of concern relates to the management of hospital chemical waste which is outside the scope of the project. Three other topics (management of microbiological, pharmaceutical/cytotoxic, and radioactive waste) are not applicable to the six hospitals. The WHO requires color coding but labeling serves the same purpose at this time. In all other areas, the HCWM model in Kyrgyzstan receives a positive mark.

5.2.2 ASSESSMENT OF THE TREATMENT METHOD

A centerpiece of the model is the use of a gravity-displacement autoclave. It is essential to evaluate the VK-75 autoclave system since it was originally designed for sterilization of medical and surgical instruments. The potential for the release of pathogens during the first steam flush must be examined. Moreover, gravity-displacement autoclaves are less efficient in removing air from the waste containers. Since air is a thermal insulator and barrier to steam penetration, this raises questions about the ability of steam to penetrate the waste and achieve the required disinfection levels in gravity-displacement autoclaves. Pre-vacuum and multiple-vacuum autoclaves enhance steam penetration but are more expensive, require more maintenance, and incur higher operating costs. In contrast, the VK-75 autoclave is affordable, easily procured, and familiar to many hospital staff and equipment technicians in Kyrgyzstan.


Figure 5.1 Filter

The issue of pathogen release is addressed in the HCWM model by adding a steam-resistant porous-metal filter (Figure 5.1) in the steam exhaust line of the autoclave. The filter captures 99.9% of all particles down to 0.2 microns. Hence, pathogens can be removed from the air with the first steam-air release. During autoclave operations, the filter and hoses are repeatedly disinfected by releases of steam from subsequent pressure pulses of the autoclave. The filter itself is decontaminated every three months by switching the input and output hoses and flushing with steam.

The first steam-air release takes place after the steam boiler pressure reaches 1.5 bar (150 kPa) corresponding to a saturated steam temperature of 127^{0}C. A better system would be to allow the pressure inside the autoclave chamber to reach 1.7 bar and then releasing the steam-air mixture. In the evaluator's own unpublished studies at the University of Dar es Salaam in Tanzania, 10^5 bacterial spores were placed at the opening of the steam exhaust line inside an autoclave. A steam flush was conducted as soon as the steam-air mixture in both the boiler and chamber reached a temperature of 130^{0}C. Cultures of samples taken from the exhaust showed no growth of bacterial spores. If this can be shown by RCIC, future autoclaves will not need any porous metal filters hence further decreasing capital costs.

RECOMMENDATION: RCIC should conduct tests of modified autoclave cycles (such as allowing the pressure in the chamber to build to 1.7 bar before the first steam-air release) to determine if microbial spores are destroyed in the steam-air mixture thereby eliminating the need for a metal filter and further reducing capital costs in the future.

With regards to steam penetration and disinfection of waste, the autoclave treatment process of the HCWM model has two features that address the issue: the removal of the lid inside the autoclave before the start of the cycle, and the use of two steam flushes. The evaluator's own studies in other countries show that two or three steam flushes from a gravity-displacement autoclave remove enough air to result in achieving the required disinfection levels. RCIC conducted several tests of the VK-75 autoclave using a combination of temperature sensors and *Geobacillus stearothermophilus* microbiological indicators. Following currently recommended practice, the thermocouples and the bacterial spores were embedded inside the waste: at the top and inside bottom of the upper container and the center and inside bottom of the lower container (see Figure 5.2). RCIC used indicators with Log 4 concentrations of the bacillus spores in keeping with the international STAATT criteria, but they also included Log 5 indicators and in some tests, even Log 6 indicators.

Typical temperature-pressure profiles are given in Figure 5.3. The temperatures inside the waste containers reached 131-133^{0}C for 10 minutes, and above the minimum temperature of 121^{0}C for more than 12 minutes. Consistent with the temperature-time exposures, all microbiological indicators demonstrated a Log 5 kill of the heat-resistant bacterial spores, exceeding by ten times the STAATT criteria of a Log 4 kill of *G. stearothermophilus*.

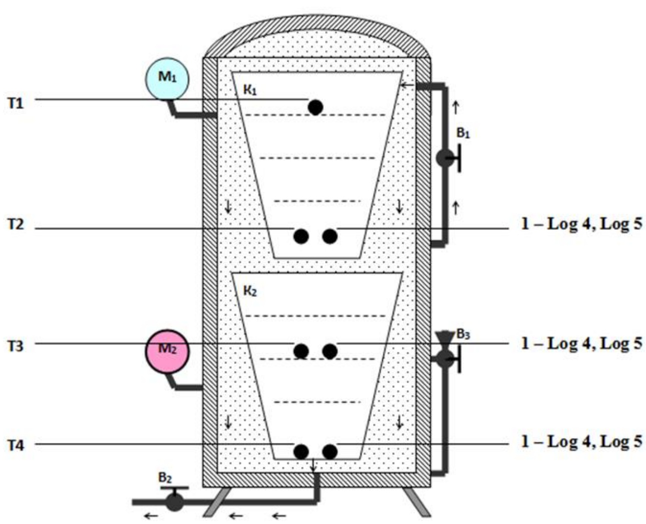


Figure 5.2 Locations of thermal sensors and microbiological indicators during autoclave tests

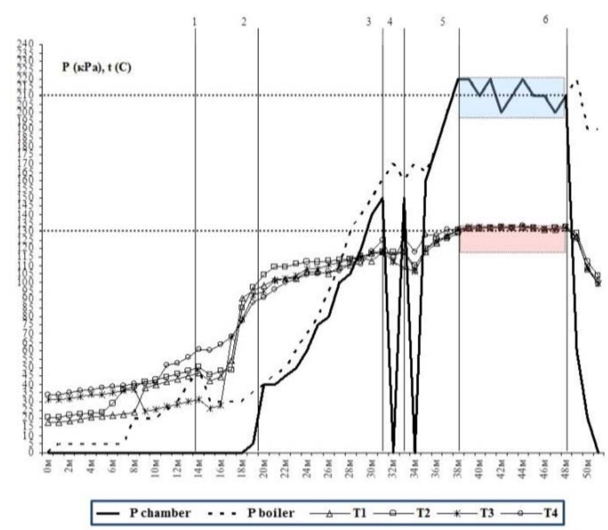


Figure 5.3 Temperature and pressure profiles inside the autoclave

The oldest autoclave visited was in Hospital C. The nameplate shows that the autoclave was originally built in 1984 (29 years old) but was refurbished and installed in 2006. It has been in operation at the hospital for 7 years during which they replaced two of the three heaters so far. The inside chamber shows only minimal corrosion and the door hinge, lock nuts, door gasket, water-level sight glass, valves, pressure gauges, pipes, couplings, and outer cover appear in good condition. The gasket lasts three to six months depending on use. Based on their experience with the autoclave, the medical equipment technicians in Hospitals C and D aver that the autoclave can last many years with good maintenance involving monthly cleaning especially of the heating elements, lubrication of valves, blow down of the boiler, and checking of gaskets. From an inspection of the autoclaves, the evaluator finds the VK-75 to be durable and of good construction.

An assessment of the needle destroyer is presented here. Hospital C had the longest experience with the needle destroyers of the six hospitals visited. They reported that out of 180 needle destroyers used since 2006, only four (2%) have broken in seven years. In general, the needle destroyers that are made with a stainless steel frame are sturdier than those made with a hard plastic frame. The most common problems are breakage of the handle, stripping of the screw that holds the cutting block, and cracks where the screws hold the frame to a table (for plastic frames only). The first two problems can be fixed. Locally made needle destroyers appear to be of good quality but are more expensive. At any rate, the needle destroyers are easy to use and last long when maintained regularly.

5.2.3 QUANTITATIVE ASSESSMENT USING THE I-RAT

Another method of assessing the HCWM model in Kyrgyzstan is through the use of the UNDP-WHO Individualized Rapid Assessment Tool (I-RAT) which was slightly modified as explained in Section 3.3. The I-RAT scores for the six hospitals are shown in Table 5.3 and details are given in Annex D.

Table 5.3 I-RAT scores of the six hospitals out of a total of 100 points

Hospital	I-RAT Score
A	93
B	93
C	97
D	97
E	96
F	92

Considering that the maximum is 100 points, the I-RAT scores of the six hospitals are high compared to many low- and some middle-income countries that generally score between 50 to 90 points.

The qualitative assessment presented in Table 5.2 and the high I-RAT scores in Table 5.3 both point to the same conclusion: The HCWM model in Kyrgyzstan addresses the main components of good HCWM in an effective and practical manner, and meets the basic criteria of protecting patients, health workers, the public and the environment from the hazards of health care waste.

The HCWM model as observed by the evaluator in the six hospitals is among the best overall compared to the status of HCWM typically found in many low- and middle-income countries. If the six hospitals are representative of the 264 hospitals in 7 oblasts that have reportedly adopted the model, then the Kyrgyz Republic is well ahead of many developing countries in its management of health care waste.

RECOMMENDATION: The HCWM model should be written up in an informational brochure and a technical paper for international dissemination in order to assist other developing countries in addressing problems of health care waste management.

5.2.4 SPECIFIC ASSESSMENT OF THE SELECTED HOSPITALS AND ADDITIONAL OBSERVATIONS

The evaluation thus far looks at the HCWM model in general. It should be noted, however, that among the hospitals some variations exist particular to the local conditions. For example, some hospitals are able to recycle glass vials while others are not. Hospitals in the colder climates report that composting takes them as much as 1.5 years due to the weather. Some hospitals have their own medical equipment technicians with good experience in maintaining and repairing autoclaves while other hospitals do not.

Most hospitals reported an initial resistance to implementing the new system. The director of Hospital B was doubtful at first but now extols its benefits. The director of Hospital A admitted that she was very much against the new HCWM system in the beginning but now she is completely in favor of it, so much so that she has invited other hospitals to visit their model. She is especially pleased at how the new system resulted in an overall cleanliness of the hospital campus.

Like Hospital A, Hospital E has hosted representatives from other hospitals to see their system including participants of a medical workshop held at the hospital on July 2013 and medical workers from Georgia in 2012. Hospital C has participated in information exchanges to convince other hospitals in the oblast to adopt the new system. Taking advantage of their training and experience, they train staff of other hospitals in HCWM. The infection control specialist in Hospital C has been a champion of HCWM and infection control in the region.

An indication of the degree of ownership of the new system is the co-financing in cash or in kind provided by the hospitals. During the project, all six hospitals covered the cost of renovating a space for the autoclave treatment. Since project funding ended, hospitals have been covering the cost of additional containers, PPE, disinfectants, color-changing indicators, office supplies related to HCWM, and the salaries of one or two staff persons. Hospital C plans to purchase a second autoclave. With additional revenues from recycling, Hospital D has purchased five additional needle destroyers and plans to enhance the layout of their autoclave room by adding a receiving area and installing a second door so that untreated waste enters one door and clean containers and treated waste exit the other. Like the other hospitals, they now cover all costs for HCWM.

As described at the end of Section 4, cost-sharing arrangements allow optimum use of the treatment system. The director of Osh City Territorial Hospital reported that they share their treatment system with five other area hospitals and use a transport vehicle to collect the waste.

A detailed assessment of each hospital finds some minor issues and inconsistencies that are worth noting. Although these variances are not significant to alter the overall assessment, it is important that they be addressed during the final months of the project. Specific issues are described below:

- Hospital A uses an old autoclave process cycle and does not use binder clips to hold the container lids. This is reportedly due to some delays in upgrading to HCWM model in some hospitals.
- Hospital A encloses anatomical waste in plastic bags before placing them in the anatomical waste pits. Doing so retards the decomposition of the waste. The problem is purportedly due

to ambiguity in the national guidelines and pressure from the local SES (Sanitary and Epidemiologic Service, now called the State Center for Sanitary and Epidemiologic Control).

- In one needle destroyer in Hospital B, the cutting block had not been adequately tightened. Except for this one case, needle destroyers elsewhere appeared in good working condition.
- Hospital E rearranged the autoclave treatment room layout in a way that does not maintain separation between the clean areas and the contaminated areas, thereby increasing the risk of cross-contamination. The project should check to make sure that hospitals maintain the layout of their autoclave rooms to prevent cross-contamination. Additional funds could be provided to improve on the layouts of other hospitals if necessary.
- Hospital F did not properly segregate the waste when giving injections in patient rooms and other rooms without a needle destroyer. The medical staff had to transport the contaminated syringes in kidney bowls, walking a long distance to the needle destroyer. In cases where patients have to be given injections where no needle destroyers exist, the injections, needle destroyer, and waste containers should be transported on a nurse's trolley or cart brought to the patient room.
- Some hospital personnel were confused on the proper way of removing PPE after transporting waste.
- In Hospital B, the steam exhaust vented outside the building and pointed potentially at the legs of passers-by. A simple cover should be added to diffuse the steam and prevent contact with passers-by.
- Some hospitals still provide injections of vitamins and other unnecessary injections. Promoting the elimination of unnecessary injections reduces the amount of sharps waste.

RECOMMENDATIONS:
The project should conduct random spot-checks of hospitals to ensure consistency with the HCWM model. Instructions should be sent out to all hospitals addressing common issues and problematic deviations from the HCWM model as described above.
The change to the new autoclave process cycle and the use of binder clips should be completed in all hospitals.
The national guidelines should clearly specify the elimination of plastic bags when disposing of anatomical waste in the anatomical waste pits so as to avoid confusion.
The project should check to make sure that hospitals maintain the layouts of the autoclave treatment rooms such that contaminated and clean sections are kept separate and the movement of waste goes from dirty to clean. Additional funds could be provided to some hospitals to improve their layouts if necessary.
The procedure for giving injections to patients in locations without a needle destroyer should be clarified to require that the injections, needle destroyer, and waste containers be transported in nurse's trolleys or carts to the patient.
The training programs should include the proper way of donning and removing PPE.
A simple cover should be added to the steam exhaust vent to diffuse the steam and prevent direct contact with passers-by outside the autoclave treatment room.
The MOH should promote the elimination of unnecessary injections in hospitals.

5.3 Assessment of Administration and Financing

The project was administered by the Swiss Red Cross through its office in Bishkek. A project coordinator (Nurjan Toktobaev) worked with the hospitals in implementing the HCWM system, providing much of the training and monitoring developments in the hospitals. All hospitals visited approved highly of his method of work and the HCWM personnel were appreciative of his hard work and collegial nature. The evaluator found Dr. Toktobaev very knowledgeable and effective. The project was one of several projects under the supervision of SRC's Dr. Tobias Schueth who worked closely with the coordinator in all phases of the project. Dr. Schueth's approach of seeking practical, effective, and affordable solutions that are appropriate to the country is reflected in the outcome. His vision and direction led to the success of the project. Rather than imposing a solution, the project worked closely with RCIC and the hospitals to develop an appropriate model, helped build local capacity, and implemented the model in an interactive and participatory manner. As the director of Hospital C told the evaluator, the project was "outstanding" compared to other projects in that "instead of giving us fish, the project gave us the tools to fish." It is evident that the project was administered effectively such that the objectives of the project were met or exceeded.

As of 2013, the project spent 2063313 CHF for equipment, training, and monitoring (see Table 5.4).

Table 5.4 Project Expenditures in CHF (as of 2013)

	Quantity	Cost
Waste Management Equipment		
Needle destroyers	2199	70368
Containers	9152	77792
Autoclaves	119	670922
Trailers	119	278460
Construction of storage areas	119	833476
Personal protection equipment	120	9960
Autoclave filters	190	58000
TOTAL	12018	1998978
Training & Monitoring		
Training of technicians	119	5950
Training of medical staff	119	10115
HCWM posters	1190	1511
Educational materials	1190	1012
Monitoring	663	45747
TOTAL	3281	64335
Total for the Project		2063313

Since the project covered almost all hospitals with 25 beds and higher except for a few specialized hospitals (i.e., the project covered 67.3% of all hospital beds for a country with a population of 5551900), the prorated cost per covered population is about 0.61 USD per covered population. This figure could be compared to the World Bank and GEF projects intended to implement HCWM in all of Vietnam (UDS 156 million for a population of 88775700), amounting to 1.76 USD per capita. A GEF project on HCWM in Kazakhstan totals USD 19.4 million including co-financing from the country or 1.15 USD per capita. These figures suggest that the SDC-funded project in Kyrgyzstan is cost efficient.

6. DESCRIPTION OF THE ACHIEVED RESULTS

The achievements of the project are best understood in the context of the situation in the hospitals before the project was initiated. For example, Hospitals D, E, and F described their hospital campuses as full of garbage that was generally dumped in one place and burned. Often the staff would have to pour kerosene on the waste, light it up, and then stand by the waste to watch it while it burned thereby breathing noxious fumes. The smoke led to many complaints by the neighbors. Burning during the winter or on rainy days was difficult. There was no segregation so everything was discarded. In the case of Hospital D, the ash and other waste from the hospital was dumped in a river.

The old system required the use of a lot of chemical disinfectants, primarily sodium hypochlorite purchased in large volumes. Different types of waste were soaked in the disinfectant at different concentrations for different periods of time—about 10 containers with varying concentrations of hypochlorite solutions were needed. Because hypochlorite solution degrades quickly and its potency is affected by sunlight and organic matter, the medical staff had to prepare fresh solutions each day. This meant that the staff was frequently exposed to a corrosive disinfectant that is an irritant to mucous membranes, eyes, and skin. Nurses reported that much of their time was spent in preparing these disinfectant solutions, monitoring the time that the waste had been soaking, removing the waste for disposal, and preparing new solutions.

Syringes were collected in single-use cardboard safety boxes which were designed to be burned. These boxes incurred some cost. When safety boxes were not available, regular cardboard boxes would be used, then taped up and burned. Burning was often done in open pits or ovens which would not reach high temperatures. Hence, some needles would generally survive intact. Some hospitals would break off the needles by hand and burn them separately. Since sharps and infectious wastes were first soaked in the chlorine compound, burning them would have generated significant levels of highly toxic chlorinated dioxins and furans released in both the smoke and ash.

Some hospitals buried anatomical waste in open holes but the anatomical parts would often be dug up by animals. The burial pits did not have liners and therefore posed a risk of contamination of the groundwater. Other hospitals had problems because of limited burial spaces in cemeteries.

Today, the scenarios described above have been eliminated in all the hospitals covered by the project and replaced with an exemplary HCWM system that can serve as a model for other developing countries. The hospital visits confirmed the following results which were immediately apparent during the visits:

- ✓ No burning of wastes
- ✓ No burn pits or ovens and no toxic ash
- ✓ No open burial pits for anatomical waste
- ✓ No wastes left lying around the hospital premises.

The project aimed to have 119 functioning HCWM systems in 181 medical facilities in Batken, Osh, Jalal-Abad, and Chuy oblasts. In many cases, a cluster arrangement allowed one treatment system to serve the Family Medical Centers, dental facilities, private clinics, and some specialized facilities within the campus or vicinity of the main hospital, thereby maximizing the use of the treatment facility. As of the date of this evaluation, the HCWM system was reportedly serving 264 medical facilities in the 7 oblasts in the country, as well as in Osh City. The list of hospitals in which the treatment system has been installed is given in Annex C. The project was able to cover all hospitals with 25 beds and higher (except for 12 tuberculosis hospitals, 2 psychiatric hospitals, and 3 rehabilitation hospital), plus several republican hospitals. These facilities corresponded to about 17,447 hospital beds out of the 25,906 hospital beds in the country or 67% of total hospital beds (see Table 6.1).

Table 6.1 Coverage of the project in terms of hospital beds

Regions & Health Facilities	Beds	Covered by project	% covered	Notes
Republic Organizations	6413			Republican hospitals, national centers are located mainly in Bishkek
Bishkek City	2174			Bishkek not covered by the project
Osh City	970	970	100	
Batken Oblast	1879	1779	94.7	Hospitals with <25 beds not covered
Jalal Abad Oblast	4074	3740	91.8	Hospitals with <25 beds not covered
Issyk Kul Oblast	1351	1467	108.6	National hospital center for tuberculosis included
Naryn Oblast	911	907	99.6	Hospitals with <25 beds not covered
Osh Oblast	5139	4934	96.0	Hospitals with <25 beds not covered
Talas Oblast	733	733	100.0	
Chui Oblast	2262	2917	129.0	Psychiatric and national hospital center for tuberculosis included
Total:	**25906**	**17447**	**67.3**	

During interviews, the staff consistently pointed out that the new HCWM system markedly decreased their exposures to hypochlorite and felt that the new procedure was more protective of their health. Furthermore, they felt that the sharps waste management system employing needle destroyers improved occupational safety by reducing needle-stick injuries.

Hospital C provided data on needle-stick injuries and cuts from 2005 to 2013. Needle destroyers were introduced in 2006. There was an initial increase in the injury data for 2007 partly due to improved documentation and a change in reporting framework from a punitive approach to safety improvement. Since then, needle-stick injuries and cuts have decreased compared to the 2005 baseline year (Figure 6.1).

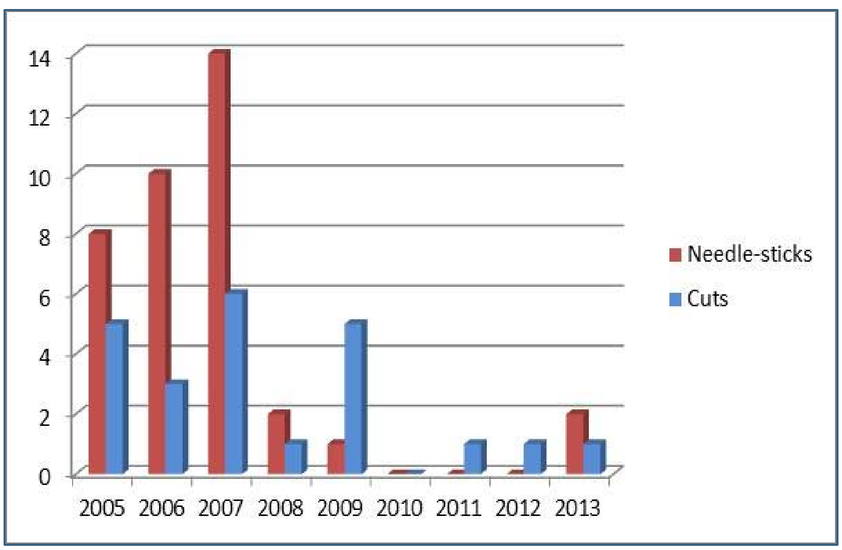


Figure 6.1 Decrease in needle-stick injuries and cuts in Hospital C

Hospital directors in the six hospitals reported cost savings because of the HCWM system. The biggest savings were due to reduction in disinfectant use, followed by the elimination of single-use sharps safety boxes. These savings more than offset the added costs of plastic bags for regular waste and autoclave electrical consumption in most hospitals. For example, Naryn Hospital has a net annual saving of 37145 KGS compared to the baseline year 2005 and the recycling of plastics and metals brings in revenues of 29140 KGS (Table 6.2). Note that the expenses exclude the staff salary for the infection control specialist and autoclave technician which the hospital covers.

Table 6.2 HCWM Income and Expenses for Naryn Hospital (Before and After the Project)

EXPENSES

ITEMS	2005		Current	
	Units	KGS	Units	KGS
Disinfectants	446 kg	57600	227	10014
Sharps safety boxes	816 boxes	16320	0	0
Waste removal fee	416 tonnes	20800	90	12600
Plastic bags for Class A waste	0	0	9125	18250
Plastic bags for autoclave	0	0	1715	3425
Electricity	0	0	8694 kWh	13286
TOTAL		94720		57575

INCOME

ITEMS	2005		Current	
	Units	KGS	Units	KGS
Sale of plastics	0	0	2300 kg	27600
Sale of metals	0	0	140 kg	1540
TOTAL		0		29140

A 452-bed hospital fills up as much as two large sacks of needle-less plastic syringes every 1.5 weeks and one 200-liter drum of needles every two months. Naryn Hospital sells the plastics for about 12 KGS/kg and the metal for about 11 KGS/kg. Hospital E sells the plastics for about 7 KGS/kg.

Data from other hospitals show a similar pattern as that in Naryn Hospital. Table 6.3 shows data from 30 hospitals. Although a few hospitals saw an increase in expenditures, most hospitals achieved cost savings. The 30 hospitals in Table 6.3 recorded an average savings of 50858 KGS or 33% compared to costs before the project. In general, the HCWM costs account for 0.68% of the operating budgets of the hospitals.

Table 6.3 Comparison of annual HCWM costs before and after the project

№	Health care organizations	HCWM costs before the project, KGS	HCWM costs after the project, KGS	Savings in KGS
1	Jeti Oguz TH	73000	57500	15500
2	Blykchy TH	116517	101280	15237
3	Issyk Kul TH	17500	11000	6500
4	Tup TH	32500	2850	29650
5	Ak Suu TH	169082	157306	11776
6	Issyk Kul Oblast Joint Hospital	822810	535294	287516
7	Tokmok TH	155300	146942	8358
8	Kochkor TH	76000	68372	7628
9	Nariman TH	113750	83533	30217
10	Moscowskaya TH	145205	80151	65054
11	Jaiyl TH	260097	201383	58714
12	Batken Oblast Joint Hospital	319500	93600	225900

13	Kara Buura TH	92981	32250	60731
14	Jany jer CGPP	48000	24400	23600
15	Kulundu CGPP	34000	32216	1784
16	Kyzyl Kiya TH	232000	266550	-34550
17	Samarkandek TH	15885	43440	-27555
18	Oash City perinatal center	243440	202140	41300
19	Osh City TH	429750	182541	247209
20	ОМОДКБ	198036	122640	75396
21	ОМОКБ	140400	43000	97400
22	Nookat TH	237500	141600	95900
23	Kara Suu TH	116000	44826	71174
24	Chon Alai CGPP	48000	53972	-5972
25	Suzak TH	77000	74500	2500
26	Jalalabad Oblast Blood Center	8900	25750	-16850
27	Nooken TH	195000	153659	41341
28	Mailuu Suu CGPP	70264	51700	18564
29	Tash Komur City TH	97688	63100	34588
30	Naryn Oblast Joint Hospital	94720	57575	37145
	Total:	**4680825**	**3155070**	**1525755**

Hospital staff complained that in the past there were many committees dealing with related issues. One side benefit of the project was the streamlining and consolidation of related tasks under a Safety & Quality Committee which deals with HCWM, infection control, worker and patient safety, and quality improvements. When asked to describe the most positive and negative impacts of the project, hospital directors most often highlighted the cost savings and the elimination of neighborhood complaints due to burning. Hospital staff invariably stated that the new system made their work easier by eliminating the old system of chlorine disinfection of waste thus allowing them to spend more time with their patients. They also appreciated the enhancement of occupational safety and health. No negative impacts were mentioned by any hospital.

Several side benefits of the project are worth noting. Hospital D is located in an area without a landfill. The implementation of the HCWM system in the hospital made the hospital administration more cognizant of the importance of a landfill. Consequently, the hospital has been working with the local authorities to develop a landfill site in the area.

The main side benefits of the project on the national level are as follows:

- Twelve articles in MOH Decree 59 deal with health care waste management due to the input of the Republican Center for Infection Control and the Swiss Red Cross based on lessons learned from the project.
- The Medical Accreditation Commission has adopted the HCWM guidelines developed by the Republican Center for Infection Control with support from the Swiss Red Cross and the project.
- The level of awareness and interest in HCWM among hospitals and health care facilities not covered by the project has increased as hospitals under the project invite other hospitals to see the HCWM model in operation.

7. EVALUATION OF RELEVANCE, EFFICIENCY, EFFECTIVENESS, IMPACT, AND SUSTAINABILITY

Each of the topics and subheading identified in Section 3.4 is evaluated in column 2 and scored in column 3 in Table 7.1.

Table 7.1 Evaluation of Relevance, Efficiency, Effectiveness, Impact, and Sustainability

Topic/Subheading	Notes	Score
	Relevance	
Relevance at conceptualization	An assessment of the health care situation in Kyrgyzstan properly identified the lack of a comprehensive HCWM system as a threat to patients, staff, the community and the environment.	4
Relevance today	HCWM remains a relevant issue in Kyrgyzstan, in the region, and globally as many developing countries continue to grapple with the issue.	4
Quality of design	The project took a very practical approach, giving strong consideration to environmental protection and occupational safety, and emphasizing simplicity and ease of use, affordability, the potential for revenue generation, use of locally available materials and local manufacturing where possible. These factors increase the likelihood of sustaining the results.	4
Quality of intervention	The HCWM model was piloted and refined in a few hospitals before it was expanded, making use of the lessons learned from the early adapters. Hospital personnel have commended the project coordinator (NT) for taking a collegial and interactive approach, soliciting stakeholder participation in the implementation of the new HCWM system. This approach effectively lessened the resistance to the new system and helped achieve the desired results.	4
Complementarity with other projects	The Global Fund to Fight AIDS, Tuberculosis and Malaria incorporated some aspects of the project in their activities but there appeared to be weak coordination with the project. A UNDP GEF project is in the project preparation phase with some input from the project.	2
	Efficiency	
Efficiency of administration	The project was managed from the SRC office in Bishkek with one project coordinator (NT) who traveled to all the areas covered by the project. The project was among other projects under the supervision of SRC (TS). This arrangement got the job done.	4
Cost efficiency	The project is cost efficient as explained in Section 5.3.	4
Timeliness	Although some hospitals have not completed the transition to the new autoclave cycle and have not made other recent changes, the project is expected to be completed by March 31, 2014.	3
Involvement of beneficiaries	The SRC worked closely with RCIC and with hospital directors, infection control officers and epidemiology specialists in all the hospitals.	4
Comparison to alternatives	Alternative approaches include centralized and mobile treatment which would be impractical in rural areas due to the condition of roads. The use of color-coded plastic bags instead of reusable enamel containers would incur significant costs. Vacuum autoclaves and microwave systems have higher purchase costs. Incinerators with pollution control devices that meet international standards would be cost prohibitive in both capital and operating costs. The only alternative that may have been more efficient is a national training of trainers program in coordination with RCIC and SES. Such a program could have created a network of master trainers and	3

	experts for all of the regions to assist in implementation, monitoring, training, and continuous improvement.	
	Effectiveness	
Attainment of primary objective	All targeted facilities of the covered regions have functioning HCWM systems.	8
Attainment of output 1	Output 1 has been achieved. The HCWM equipment is installed and functioning in the hospitals. See Section 5.1.	6
Attainment of output 2	Output 2 has been achieved. Personnel use and manage the system well. See Section 5.1.	6
	Impact	
Impact on target group	The staff and patients of the 181 facilities in Batken, Osh, Jalalabat, and Chui oblasts, with their personnel and staff are the primary beneficiaries but the positive impact extends to 264 facilities in all oblasts and Osh City. The communities at large around these hospitals have to be considered beneficiaries as well because of the reduced environmental hazards.	8
Contribution to overall objectives	The overall goal is to improve infection control in Kyrgyz hospitals. While good HCWM contributes to the overall goal, the other project (outcome 2 on improving infection control in maternities) addresses the issue in a more immediate and direct way.	5
Indirect impacts	There were significant indirect impacts, ranging from improvements in local landfills to incorporation of HCWM guidelines into national decrees and accreditation requirements.	4
	Sustainability	
Financing	The HCWM system results in cost-savings to most hospitals in comparison to their past practices. The recycling of plastics and metal results in additional revenues which are used to sustain the HCWM system.	6
Capacity building	Trainings of medical and technical personnel were conducted under the project. These were supplemented by posters, educational materials, and monitoring visits. After the project, training expertise will continue to reside in the RCIC. Perhaps creating a network of master trainers and regional experts through a national Training of Trainers program and conducting joint training with local SES personnel could lessen reliance on a national body and avoid confusion between RCIC and SES guidances.[3]	4
Policy, roles & responsibilities	The hospitals had policies on HCWM and organizational charts which spelled out the roles and responsibilities of the Safety & Quality Committee and the staff.	6
Institutional culture	The HCWM system saves time for the medical staff compared to the previous practice thereby allowing the medical staff to spend more time on patient care. The HCWM system also reduces occupational exposures to chemical disinfectants. These two factors have resulted in greater acceptance of the new system among the staff. Furthermore, periodic training, monitoring, and improvement have made the new HCWM practices routine and part of the culture of the institution.	2
		91

[3] Training of Trainers (TOT) is now being used for training infection control specialists in seven oblasts and Bishkek central hospitals. The TOT program, which includes learning about the HCWM model, was started in the Spring 2013.

A total of 91 points out of 100 further reinforces the conclusion that the SDC project implemented by SRC was well conceived, designed, and implemented, resulting in positive impacts with a high likelihood of being sustained after the project.

8. CONCLUSIONS

The project has achieved its stated objectives under outcome 1 of the Project Document's Logical Framework. Except for a few remaining tasks, the work is basically complete and the project can be concluded by the end of March 2014 as planned.

The qualitative assessment presented in Table 5.2 and the high I-RAT scores in Table 5.3 both point to the same conclusion: The HCWM model developed by the Republican Center for Infection Control in collaboration with the Swiss Red Cross addresses the main components of good HCWM in an effective and practical manner, and meets the basic criteria of protecting patients, health workers, the public and the environment from the hazards of health care waste. Therefore, the basic model should be replicated in all other hospitals in Kyrgyzstan except for some modifications discussed in the Recommendation section.

Recommendation: The HCWM model should be replicated in all other medical facilities in Kyrgyzstan including FMCs, FGPs, FOPs, and private facilities.

The HCWM model is exemplary and could serve as a model for other countries. Because of the project, the Kyrgyz Republic is well ahead of many low- and middle-income countries in its management of health care waste.

9. SUMMARY OF RECOMMENDATIONS

This section summarizes the recommendations made so far and makes additional recommendations within and beyond the scope of the project. The recommendations are arranged into three groups: (a) recommendations to SRC for improving the HCWM model before the end of the project; (b) recommendations to the Ministry of Health related to the HCWM model for the near future; and (c) recommendations to the Ministry of Health for the long term to address issues outside the scope of the project.

Recommendation to SRC for Improving the HCWM Model before the End of the Project

- **The project should conduct random spot-checks of hospitals to ensure consistency with the HCWM model. Instructions should be sent out to all hospitals addressing common issues and problematic deviations from the HCWM model as described in Section 5.2.4.**
- **The change to the new autoclave process cycle and the use of binder clips should be completed in all hospitals.**
- **The HCWM model should be written up in an informational brochure and a technical paper for international dissemination in order to assist other developing countries in addressing problems of health care waste management (see Annex E for suggested content of the brochure and technical paper).**

Recommendations to the Ministry of Health for the Immediate Future Related to the HCWM Model

- **The national guidelines should clearly specify the elimination of plastic bags when disposing of anatomical waste in the anatomical waste pits so as to avoid confusion.**
- **The project should check to make sure that hospitals maintain the layouts of the autoclave treatment rooms such that contaminated and clean sections are kept separate and the movement of waste goes from dirty to clean. Additional funds could be provided to some hospitals to improve their layouts if necessary.**
- **The procedure for giving injections to patients in locations with no needle destroyer should be clarified to require that the injections, needle destroyer, and waste containers be transported in nurse's trolleys or carts to the patient.**
- **RCIC should conduct tests of modified autoclave cycles (such as holding the pressure at 1.5 bar for 1-2 minutes before the first steam-air release) to determine if microbial spores are destroyed in the steam-air mixture thereby eliminating the need for a metal filter and further reducing capital costs in the future.**
- **A simple cover should be added to the steam exhaust vent to diffuse the steam and prevent direct contact with passers-by outside the autoclave treatment room.**

> **➢ The training programs should include the proper way of donning and removing PPE (see Annex E).**

Two other recommendations are made as further refinements to the HCWM model. Some national and international standards require periodic microbiological testing of waste autoclaves, a requirement that could incur significant cost for low- and medium-income countries. The frequency of testing ranges from weekly to every 40 hours of use to monthly testing. RCIC should consider the use of Class 5 steam integrators in lieu of monthly microbiological testing. Class 5 indicators are designed to react to temperature, pressure, and time and their performance is correlated by the manufacturers to the performance of biological indicators under specified conditions of use. Some steam integrators use a window across which a colored strip migrates; they are sometimes called moving front indicators. When adequate sterilization conditions are met, the colored strip crosses a FAIL/PASS line. Other steam integrators use an indicator that gradually changes towards a dark color. As soon as specified sterilization conditions are met, the indicator becomes as dark or darker than a color standard used for comparison. A steam integrator can be placed in the middle of the waste in each of the containers as part of a monthly test and the results included in the journal of the autoclave technician. Class 1 indicators can be minimized to one per container and used primarily to affix to the journal as permanent proof of treatment.

Calcium hypochlorite for disinfecting placenta and anatomical waste has the advantages of being more stable as a powder than sodium hypochlorite solution, having a high chlorine concentration for effective disinfection, and being able to reduce odors. Its disadvantage when used in anatomical waste pits is that it could also destroy many beneficial microorganisms needed to decompose the waste. Suggestions are made in Annex E on possible options to improve the process.

> **➢ RCIC should consider requiring the use of Class 5 steam integrators for monthly testing of the autoclaves in lieu of monthly microbiological testing. The number of Class 1 indicators can be minimized and used primarily as proof of treatment.**
> **➢ Suggestions are made in Annex E on possible options to enhance the decomposition of anatomical waste in the waste pits.**

Recommendations to the Ministry of Health for the Long-Term to Address Issues beyond the Scope of the Project

> **➢ The HCWM model should be replicated in all other medical facilities in Kyrgyzstan including FMCs, FGPs, FOPs, and private facilities.**
> **➢ The MOH should promote the elimination of unnecessary injections in hospitals.**

As noted in Section 6, the HCWM model developed by the RCIC and SRC has been replicated in seven oblasts as well as the city of Osh, leaving the small rural hospitals/clinics and the capital city of Bishkek as the major gaps not covered by the project.

In small rural hospitals and clinics where the amounts of health care waste are small and a VK-75 autoclave is cost prohibitive, the use of small pressure cookers as a practical and affordable version of an autoclave should be considered. Most small, commercial pressure cookers found in markets operate at 1 bar pressure, corresponding to about 121°C, the minimum temperature used in autoclaves. The pressure cooker could serve as the waste container itself. As the evaluator discovered in his unpublished studies of pressure cookers, wiping the inside surfaces of the cooker with a small amount of cooking oil and covering them with old newspapers are enough to prevent any sticking of melted plastics in the waste. RCIC should test locally available pressure cookers to check the pressure, determine the amount of water to be added, and specify how long to expose the waste to pressurized steam to reach the minimum disinfection levels. A combination of a needle destroyer and pressure cooker painted with the biohazard symbol is a practical approach. Assuming a cost of USD 30 per pressure cooker and USD 35 per needle destroyer plus USD15000 for training and monitoring, it may be possible to train and equip all 1500 FOPs and FGPs with a viable HCWM system with a budget of about USD 113500.

The HCWM model should be modified for small rural facilities and immunization programs by replacing the VK-75 autoclave with a small pressure cooker as a practical and affordable alternative. RCIC should conduct tests of pressure cookers in order to provide guidelines on their use in small facilities (see Annex E).

There are four possible approaches to health care waste treatment for an urban center like Bishkek: decentralized treatment wherein each hospital has its own treatment system, centralized treatment wherein waste from the entire city is collected and treated in one central plant, cluster treatment wherein several hospitals act as hubs for treating waste from clusters of health facilities nearby, mobile treatment wherein a mobile treatment system treats waste at one hospital then moves to the next, or a combination of the above. According to the MOH, the Global Fund to Fight AIDS, Tuberculosis and Malaria installed about 30 autoclaves in hospitals in Bishkek. However, the autoclaves do not appear to have been sized properly and there may have been difficulties in designing and implementing the cluster approach in Bishkek.

For Bishkek, the evaluator recommends replicating the HCWM model with some modifications and incorporating the model into a well designed and implemented cluster treatment system. A well-designed cluster system requires the careful selection of cluster hubs or hospital hubs (the hospitals that will treat the waste within their respective clusters). The selection of cluster hubs involves:

- Awareness-raising and stakeholder participation in the determination of the clusters
- Interest by the city administration in supporting the HCWM infrastructure and cluster approach
- High level of interest and commitment of directors and staff of the hospitals that will act as cluster hubs
- Central location of the hospital hub in relation to the other medical facilities in the cluster
- Available space inside the hospital for a treatment site that is away from patients
- Minimal impact on the hospital by increased traffic due to waste collection vehicles
- Available space for the storage of waste
- Available electricity at the hospital hubs
- Analysis of transportation conditions (status of roads, traffic, distances, winter conditions, obstacles, etc.) to delineate the best combination of clusters for the city

- Routing of vehicles to optimize collection times and to ensure that all waste from the hospitals in the cluster can be collected within 24 hours (this includes conducting a test of the collection route during the actual times of collection)
- Analysis of current waste generation rates of hospitals in the clusters to determine the required transportation, storage, and treatment capacities, and analysis of projected waste generation rates for the next 20 years
- Using the current and projected waste generation data to calculate the ideal size of the storage room and the capacity of the collection vehicle
- Using the waste generation data and cost data to determine the numbers of VK-75 autoclaves needed in each hub (note that autoclaves can be run in parallel with some overlap in the autoclave cycle such that a technician can put in or remove waste from one autoclave while the other autoclave is sterilizing)—an advantage of multiple autoclaves is that operations do not have to stop if one autoclave needs maintenance or repair; an economic analysis should compare the costs of running two or more shifts versus purchasing multiple autoclaves; an economic analysis should also compare the costs of purchasing two or more CK-75 autoclaves versus a larger size autoclave
- Economic analysis that optimizes the cluster arrangements taking into account the equipment costs (one or more autoclaves, containers, needle destroyers, posters, PPE, trailers, etc.), renovation or construction costs, costs of collection vehicles, and operating costs (labor, electricity, distilled water, disinfectants, thermal indicators, replacement parts, collection fees and landfill fees for treated waste, etc.), as well as anticipated revenues from recycling of treated plastic, metal, glass, etc.
- Commitment of the hospitals to an equitable cost-sharing and revenue-sharing arrangement that benefits all the hospitals in the cluster
- Arrangements with the companies that collect regular municipal solid wastes and transport them to the landfill.

The main modification to the HCWM model when applied to Bishkek is the method of dealing with anatomical waste. Anatomical waste in Bishkek is presently collected and centrally managed by the Pathological and Anatomical Bureau. The anatomical waste is buried in special locations in cemeteries. In light of the existing centralized infrastructure, the evaluator recommends considering a centralized treatment system such as a large-scale alkaline hydrolysis unit (see Annex E). The same treatment system can be used to handle waste from veterinary hospitals. The UNDP GEF Project planned for Kyrgyzstan will focus on HCWM in Bishkek.

- **The HCWM model should be replicated with some modifications and integrated into a cluster treatment approach for Bishkek. Such a cluster treatment system should be carefully designed and implemented.**
- **The HCWM model should be modified for Bishkek by considering a centralized treatment system for anatomical waste, such as the technology described in Annex E.**

The project did not deal with the management of hazardous chemical waste in hospitals. These include spent disinfectants, laboratory solvents, expired pharmaceutical waste, cytotoxic or chemotherapeutic waste, radioactive waste, and mercury waste. The UNDP GEF Project planned for Kyrgyzstan will deal with mercury waste, which is timely in light of the recent Minamata Convention on Mercury. Future projects should cover the other hazardous chemical waste streams. Some suggestions are provided in Annex E.

- **The MOH and other appropriate state agencies should develop detailed guidelines on the management of hazardous chemical wastes including pharmaceutical, cytotoxic/chemotherapeutic, and radioactive waste from hospitals.**

ANNEX A

Mission Program

16-26 September, 2013

From Swiss Embassy: Remy Duiven (RD), Deputy Director of Cooperation; Elvira Muratalieva (EM), Senior Program Officer
From Swiss Red Cross: Tobias Schueth (TS) (0775)980304; Nurjan Toktobaev (NT): (0775) 983830
From RCIC Gulmira Djumalieva (GD), director of the Republican Centre for Infection Control
Translater: Ruslan Akunov (RA) 0550127748
Driver: Aleksandr Belkin (AB) 0772557900

Date	Time	What/Who/Where	Notes
Sunday 15.09.13	2.45 AM	Airport Manas, Pick up by Hotel Silk Road	
Monday 16.09.13	09.00	Pick up from hotel	Hotel Silk Road
	09.30-10.30	Briefing with Remy Duiven and Elvira Muratalieva, SDC	Office of Swiss Embassy
	10.45-12.30	Meeting with TS and NT	Office of Community Action for Health Project
	12.45-13.45	Lunch	Bishkek City
	14.00-17.00	Meeting with TS, NT, GD and her team	Republican Center of Infection Control
Tuesday 17.09.13	07.30	Pick-up from hotel and drive to airport	
	08.20-09.00	Fly to Osh City	NT and translator will accompany
	09.00.-12.00	Drive to and visit of Kara-Suu Pediatric Hospital. Meeting with medical staff, IC-specialist	Kara-Suu City
	12.00-13.00	Lunch	Kara-Suu City
	13.00-.16.00	Drive and visit to Suzak Territorial Hospital. Meeting with medical staff, IC-specialist, hospital management	Suzak viilage
	16.00-17.00	Drive to Osh City	
	Night	Meeting with Ravshan Raimbezdievich, Director of Osh City Territorial Hospital Diner and overnight in Osh City	Osh City
Wednesday 18.09.13	09.40-10.20	Fly to Bishkek	NT and translator will accompany
	11.00-12.00	Lunch	Bishkek City
	12.00-17.30	Drive to Naryn town	Office car, NT and translator will accompany
	Night	Diner and overnight in Naryn town	Naryn town
Thursday 19.09.13	09.00-13.00	Visit to Naryn Oblast Hospital. Meeting with medical staff, IC-specialist, hospital management; Visit to Maternity Campus	Naryn town
	13.30-14.30	Lunch	Naryn town

	14.30-16.30	Drive to Kochkor village	
	Night	Meeting with Murat Aliaskarov, Director, Kochkor Territorial Hospital Diner and overnight in Kochkor village	Kochkor village
Friday 20.09.13	09.00-12.00	Visit to Kochkor Territorial Hospital. Meeting with medical staff, IC-specialist, hospital management	Kochkor village
	12.00-13.00	Lunch	Kochkor Village
	13.15-14.15	Drive to Balykchy city	Office car, NT and translator will accompany
	14.30-17.30	Visit to Balykchy City Territorial Hospital. Meeting with medical staff, IC-specialist, hospital management	Balykchy city
	17.45-19.00	Drive to Cholpon-Ata city	Office car, NT and translator will accompany
	Night	Diner and overnight in Cholpon-Ata city	Cholpon-Ata city
Saturday 21.09.13	09.00-12.00	Visit to Issyk-Kul Territorial Hospital. Meeting with medical staff, IC-specialist, hospital management	Cholpon-Ata city
	12.00-13.00	Lunch	Cholpon-Ata city
	13.00-17.00 Night	Meeting with Talant Karimovich, Deputy Director of Issyk-Kul Territorial Hospital Diner and overnight in Issyk-Kul	Issyk-Kul
Sunday 22.09.13	09.00-12.00	Drive to Bishkek	Office car, NT and translator will accompany
Monday 23.09.13	09.00-12.00	Meeting with TS, NT	Office of Community Action for Health Project
	12.15-13.15	Lunch	Bishkek City
	13.15-17.00	Meeting with NT, GD and RCIC team	Republican Center of Infection Control
Tuesday 24.09.13	09.00-12.00	Presentation and discussion with Working group on guidelines on HCWM	Republican Center of Infection Control
	12.15-13.15	Lunch	
	13.30-15.00	Meeting with TS, NT	Office of Community Action for Health Project
	15.30-17.30	Meeting with Tatyana Filkova (UNDP/GEF), Maksim Surkov (UNDP Bratislava Regional Office); NT. Topic: HCWM system for Bishkek	Office of UNDP
Wednesday 25.09.13		Preparation of presentation	
Thursday 26.09.13	10.00-12.00	Presentation for Ministry of Health: Anara Eshhodjaeva , Head of Department of Curative and Prophylactic Services and Asylbek Sydykanov, Head of Public Health Department; and others	Ministry of Health
	12.00-15.00	Lunch meeting with TS, NT	
Friday 27.09.13	03.45	Departure	

ANNEX B

List of Persons Interviewed During the Meetings

(excluding nursing and technical staff interviewed during the walk-throughs)

National and local stakeholders:	
Remy Duiven	Deputy Director of Cooperation, Swiss Embassy
Elvira Muratalieva	Senior Program Officer, Swiss Embassy
Tobias Schüth	Swiss Red Cross
Nurjan Toktobaev	Swiss Red Cross
Gulmira Djumalieva	Director, Republican Centre for Infection Control
Alexei Krasov	Senior Specialist, RCIC
Nadira Soronbaeva	Infection Control Specialist, RCIC
Jyldyz Kurjunbaeva	Microbiology specialist, RCIC
Gulmira Kalbaeva	Director, Kara-Suu Pediatric Hospital
Kadicha Pratova	Deputy Director, Suzak Territorial Hospital
Ikram Anarbaev	Epidemiologist, Suzak Territorial Hospital
Ravshan Raimberdievich	Director, Osh City Territorial Hospital
Murat Atbaev	Director, Naryn Oblast Joint Hospital
Shaken Bekbolotova	Deputy Director of Nursing, Naryl Oblast Hospital
Aida Sultangazieva	Infection Control Specialist, Naryn Oblast Hospital
Nurgul Eshenova	Infection Control Nurse, Naryn Oblast Hospital
Murat Aliaskarov	Director, Kochkor Territorial Hospital
Aizat Mukash kyzy	Infection Control Specialist, Kochkor Territorial Hospital
Lira Chynasylova	Chief Nurse, Kochkor Territorial Hospital
Karypbek Derkenbaev	Technician, Kochkor Territorial Hospital
Nazgul Tulgieva	Deputy Director, Balykchy City Territory Hospital
Valentina Yaitskaya	Infection Control Nurse, Balykchy City Territory Hospital
Almira Aldasheva	Director, Issyk-kul Territorial Hospital
Talant Karimovich	Deputy Director, Issyk-kul Territorial Hospital
Working Group meeting attendees:	
Nuriliya Altymysheva	Kyrgyz state medical institute of training and retraining of medical staff, Public Healthcare Department
Alima Jougachieva	Infection Control Specialist at the National Hospital
Alexei Krasov	Senior Specialist, RCIC
Nadira Soronbaeva	Infection Control Specialist, RCIC
Nina Vashneva	Chief specialist at the Department of disease prevention and state sanitary and epidemiology control (former SES)
Nurjan Toktobaev	Swiss Red Cross
N. Shesheeva	Republican Center for immunologic prophylaxis
Emil Bogdanov	Infection Control Specialist, RCIC
Azat Bodoshov	Infection Control Specialist, RCIC
Jyldyz Kurjunbaeva	Infection Control Specialist, RCIC
UNDP GEF meeting attendees:	
Maksim Surkov	UNDP Regional Office
AleksanderTemirbekov	UNDP Krygyzstan

Tatyana Filkova	UNDP GEF Project
Alexander Bobrov	UNDP Krygyzstan
MOH meeting attendees:	
Andreas Heckmann	CIM, consultant to Bishkek's Mayor's Office on solid domestic wastes
Alexei Kravsov	Senior Specialist, RCIC
Tatyana Filkova	UNDP GEF Project
Omuraliev E.A.	WHO
Saliev D.	UNDP/Global Fund to Fight AIDS, TB and malaria
Chernysheva Anna	UNDP/Global Fund to Fight AIDS, TB and malaria
Bogdanov Emil	Infection Control Specialist, RCIC
Sultanova G.T.	Center for State Sanitary and Epidemilogical Control, Bishkek
Umarov B.	Center for State Sanitary and Epidemilogical Control, Bishkek
Sulaimanov D.	Sanitary and ecological inspection under Bishkek's Mayor Office
Burova T.	Environment Protection Department for Chui-Bishkek-Talas regions
Mukeeva Suyumjan	Chairman of Family Physician's Group Association
Toyalieva Elvira	UNICEF
Ibraeva N.	Ministry of Health
Joogachieva Alima	Infection Control Specialist at the National Hospital
Atkenova Nadira	Healthcare Department, Bishkek
Moldobekova Chynara	IC specialist at National Center for Maternity and Childhood Protection
Jumabaeva D.	IC specialist at National Center for Maternity and Childhood Protection

List of Documents Reviewed

"Project Proposal: Health Care Waste Management in Kyrgyz Hospitals – Period: 1 April 2011 – 31 March 2014," Swiss Red Cross, Community Action for Health Project, Bishkek, February 2011.

"Health Care Waste Management in Rural Hospitals in Kyrgyzstan: Progress Report April – October 2011," Swiss Red Cross, Community Action for Health Project, Bishkek, November 2011.

"Health Care Waste Management in Rural Hospitals in Kyrgyzstan: Annual Report April – December 2011," Swiss Red Cross, Community Action for Health Project, Bishkek, February 2012.

"Health Care Waste Management in Rural Hospitals in Kyrgyzstan: Half-Yearly Report January – June 2012," Swiss Red Cross, Community Action for Health Project, Bishkek, August 2012.

"Health Care Waste Management in Rural Hospitals in Kyrgyzstan: Annual Report," Swiss Red Cross, Community Action for Health Project, Bishkek, February 2013.

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ANNEX C

List of Hospitals in the Kyrgyz Republic with HCWM Systems

#	Health care facility	beds
Issykkul oblast		
1	Oblast Joint Hospital (2 campuses)	490
3	Balykchy City Territorial Hospital (Balykchy city)	170
4	Ak-Suu Territorial Hospital (Teplokulchenka village)	151
5	Jeti Oguz Territorial Hospital (Kyzyl Suu village)	121
6	Issyk Kul Territorial Hospital (Cholpon-Ata)	70
7	Center for General Physician Practice (Ananevo village)	25
8	Ton Territorial Hospital (Bokonbaev village)	95
9	Tup Territorial Hospital (Tup village)	105
10	Republican Tuberculosis Hospital (Bolnichnoe village)	180
11	Oblast FMC	
12	Oblast Center to Fight TB	60
	Total in Issyk Kul Oblast	**1467**
Chui oblast		
1	Chui Oblast Joint Hospital (2 campuses)	355
2	Jaiyl Territorial Hospital	330
3	Moscowskaya Territorial Hospital	171
4	Panfilov Center for General Physician Practice	85
5	Sokuluk Territorial Hospital	240
6	Suusamyr Center for General Physician Practice	15
7	Tokmok City Territorial Hospital (2 campuses)	246
9	Kemin Territorial Hospital	85
10	Orlovka Center for General Physician Practice	30
11	Chui Territorial Hospital	140
12	Yssyk Ata Territorial Hospital	195
13	Ivanovka Territorial Hospital	55
14	Jaiyl FMC	
15	Kara Balta Republican TB Hospital	100
16	Oblast Center to Fight TB +oblast FMC	130
17	Clinical base НЦФ	140
18	Republican Psychiatric Hospital	600
	Total in oblast	**2917**
Osh city		
	Oblast hospital	
1	Oblast Joint Hospital (2 campuses)	952
2	Interoblast child clinic	520
3	Oblast Blood center	
4	Oblast Child TB Hospital	150
5	Oblast Center to Fight TB(surgery)	220

6	Interoblast dermatovenerologic dispensary	110
7	Interoblast Center МСПС (marriage and family)	
8	Oblast Center against AIDS	
9	Oblast Hospital for disabled and Veterans	35
10	Interoblast Narkology Center	50
11	Oblast Center for Mental Health	170
12	Interoblast Oncology Center (2 campuses)	100
14	Osh city facilities	
15	City Territorial Hospital	385
16	City Territorial Hospital Branch (child hospital)	180
17	City Territorial Hospital Branch (perinatal center)	165
18	City Territorial Hospital Branch (somatics)	70
19	City Center to Fight TB (2 campuses: treatment and diagnosing.)	100
20	Child Rehab Center (+private surgery clinic)	70
	Total in Osh city	**3277**
Osh oblast		
1	Alai Territorial Hospital	190
2	Aravan Territorial Hospital	320
3	Tepekurgan Territorial Hospital Branch +FGP	37
4	Chon Alai Center of General Physician's Practice	180
5	Karakulja Territorial Hospital +FGP	220
6	Karasuu Territorial Hospital	270
7	Territorial Hospital Branch Kurmanjan Datka	70
8	Territorial Hospital Branch Stant	40
9	Child Territorial Hospital	80
10	Nariman Territorial Hospital	120
11	Nookat Territorial Hospital	420
12	Kok Jar Territorial Hospital Branch	55
13	Jany Nookat Territorial Hospital Branch	30
14	Jal Territorial Hospital Branch	25
15	Kok Bel Territorial Hospital Branch	40
16	Uzgen Territorial Hospital	380
17	Myrzaaki Center of General Physician's Practice	60
18	Kurshab Center of General Physician's Practice	90
19	Alai FMC	
20	Aravan FMC	
21	Karakulja FMC + dental clinic	
22	Karasuu FMC	
23	Baryn FMC	
24	Medigos FMC	
25	Uzgen FMC	
	Total in Osh Oblast	**2627**
Jalal-abad oblast		
1	Karakul Center of General Physician's Practice (CGPP)	100

2	Mailusuu CGPP	160
3	Tash Komur City Territorial Hospital (2 campuses)	100
4	Shamalduu Sai CGPP	62
5	Aksy Territorial Hospital	258
6	Aksy Territorial Hospital Branch, Kyzyl Jar village	55
7	Alabuka Territorial Hospital	151
8	Bazarkorgon Territorial Hospital	215
9	Bazarkorgon Territorial Hospital Branch, Mogol village	25
10	Nooken Territorial Hospital	171
11	Kochkor Ata Territorial Hospital	210
12	Suzak Territorial Hospital	276
13	Suzak Territorial Hospital Branch, Bek-Abad village	25
14	Suzak Territorial Hospital Branch, Orto Azia village	25
15	Kok Jangak CGPP	52
16	Oktyabr Territorial Hospital (2 campuses)	114
17	Toguztoro CGPP	70
18	Toktogul Territorial Hospital	135
19	Terek Suu Territorial Hospital Branch	25
20	Uchterek CGPP	30
21	Chatkal CGPP	66
22	Sumsar CGPP	30
23	Jalalabad oblast joint hospital (Main campus)	640
24	Alabuka FMC	
25	Bazarkorgon FMC	
26	Nooken FMC	
27	Regional center for medical rehab , Kochkor Ata	105
28	Suzak FMC	
29	Oktyabr FMC	
30	Toktogul FMC	
31	Oblast Reproductive Health Protection Center	
32	Oblast Center for AIDS	
33	Oblast FMC	
34	Oblast Center to Fight TB	445
35	Oblast Child Rehab Center	95
36	Oblast Blood center	
37	Southern Regional Scientific Center for cardiovascular surgery	
38	Oblast Center for Mental Health	100
	Total around Jalal-Abad Oblast	**3740**
Batken Oblast		
1	Batken Oblst Hospital	270
2	Batken Oblast Hospital Bramch, Bujum	37
3	Samarkandek CGPP	50
4	Kyzyk Kiya City Territorial Hospital (maternity house)	70
5	Kyzyl Kiya City Territorial Hospital (main campus)	440
6	Suluktu CGPP	100

7	Kadamjai Territorial Hospital	204
8	Uch Korgon CGPP	86
9	Maternity Department at Uch Korgon CGPP	25
10	Aidarken CGPP	90
11	Jany Jer CGPP	25
12	Leilek Territorial Hospital, Isfana city	222
13	Kulundu CGPP, International village	80
14	Oblast Center to Fight TB	80
15	Kyzyl Kiya FMC	
16	Leilek FMC	
17	Kulundu CGPP Branch	
	Total in Batken Oblast	**1779**
Naryn Oblast		
1	Oblast Joint Hospital (2 campuses)	452
2	Kochkor Territorial Hospital	120
3	Jumgal Territorial Hospital	100
4	Ak Tala Territorial Hospital	70
5	At Bashy Territorial Hospital	115
6	Oblast Center to Fight TB	50
	Total in Naryn Oblast	**907**
Talas Oblast		
1	Oblast Joint Hospital (2 campuses)	275
2	Manas CGPP	45
3	Kara Buura Territorial Hospital	105
4	Kara Buura TB Hospital	50
5	Bakai Ata Territorial Hospital	73
6	Talas Territorial Hospital	60
7	Oblast FMC	
8	Oblast center to fight TB	70
9	Hospital for veterans of war and labor	55
	Total in Talas Oblast	**733**
	Total Beds	**17447**

Data from the Modified UNDP GEF-WHO-HCWH Rapid Assessment Tool I-RAT

Individualized Rapid Assessment Tool • Healthcare Waste Management

Put yes/no responses in the yellow spaces in column C; use y for yes and n for no. Put text or numerical responses in the yellow spaces in column F. Numerical answers should be in the units specified and should not include any text. The final score is shown at the bottom.

From the UNDP GEF-WHO-HCWH Project assessment tool I-RAT modified for Kyrgyzstan

#																			
	Date of assessment	September 17 to 21, 2013																	
	BASIC DATA																		
	Name of the healthcare facility:	Hospital A			Hospital B			Hospital C			Hospital D			Hospital E			Hospital F		
	Number of beds:	80			215			452			120			170			70		
#		"y" or "n"	Value	Score	"y" or "n"	Value	Score	"y" or "n"	Value	Score	"y" or "n"	Value	Score	"y" or "n"	Value	Score	"y" or "n"	Value	Score
	ORGANIZATION																		
1	Is there a person in charge of healthcare waste management?	**y**	5	5	**y**	5	5	**y**	5	5	**y**	5	5	**y**	5	5	**y**	5	5
2	Is there a permanent committee that deals with healthcare waste management and meets on a regular basis?	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5
3	Are the roles and responsibilities regarding healthcare waste management made clear to the staff?	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5	**y**	1.5	1.5
	POLICY AND PLANNING																		
4a	Does the healthcare facility have written policies dealing with healthcare waste management?	**y**	2	2	**y**	2	2	**y**	2	2	**y**	2	2	**y**	2	2	**y**	2	2
4b	Does the healthcare facility have written plans, manuals, or written procedures dealing with healthcare waste management?	**y**	2		**y**	2		**y**	2		**y**	2		**y**	2		**y**	2	

5	Are the policies, plans, manuals, and/or written procedures consistent with national laws, regulations, and any permits?	y	3.5	3.5	y	3.5	3.5	y	3.5	3.5	y	3.5	3.5	y	3.5	3.5	y	3.5	3.5
6	Does the healthcare facility have a plan for recycling or waste minimization?	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5
7	Does the healthcare facility policy explicitly mention a commitment to protect the environment?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
8	Is the healthcare facility mercury-free? OR Does the healthcare facility have a policy or plan to phase out mercury?	n	1.5	0	n	1.5	0	n	1.5	0	n	1.5	0	n	1.5	0	n	1.5	0
	TRAINING																		
9	Does the facility have a training program on healthcare waste management for managers, health professionals, waste workers, and auxiliary staff?	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5
10	Does the training program include relevant national laws and regulations?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
11	Does the training program include the following: segregation, collection and handling of sharps waste, use of proper containers and bags for infectious waste, color coding, 3/4th fill rule, use of personal protection equipment by waste workers, transport, storage, and treatment?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
12	Are the staff trained, including new staff when they begin their employment?	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3
13	Is there refresher training at least once a year?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
	OCCUPATIONAL HEALTH AND SAFETY																		
14	Do the policies and plans related to healthcare waste management include occupational health and safety (including policies for needle-stick injuries or exposure to blood splatter)? OR Does the facility have separate	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3

	occupational health and safety policies that include needle-sticks and exposure to blood?																		
15	Are the workers who collect, transport and treat waste provided with the proper personal protection equipment (gloves, shoes or boots, and aprons)?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
16	Are the health workers and workers handling waste given hepatitis and tetanus vaccinations?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
	MONITORING, EVALUATION AND CORRECTIVE ACTION																		
17	Is there a system of internal monitoring or inspection to determine compliance with healthcare waste management requirements?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
18	Is there a system of taking corrective action when practices or technologies related to healthcare waste management do not meet the requirements?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
19	Are policies and/or plans reviewed or updated at least once a year?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
	FINANCING																		
20	Does the facility have an annual allocation in its budget for healthcare waste management?	n	4	0	n	4	0	y	4	4	y	4	4	y	4	4	n	4	0
21	Is the current budget sufficient for healthcare waste management?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
22	Does the facility have a long-term financing plan or mechanism to cover the costs for sustainable healthcare waste management?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
	PART II: POST-INSPECTION TOUR INTERVIEW																		
	CLASSIFICATION AND																		

	SEGREGATION																		
23	Are the wastes properly segregated at the source according to different categories?	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5
24	Are the health workers familiar with the classification and segregation requirements?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
	WASTE GENERATION DATA																		
25	Have the amounts of total waste and infectious waste produced per day been measured?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
	Estimated percentage of infectious waste relative to total waste:	**20**	0.5	0.5	**20**	0.5	0.5	**20**	0.5	0.5	**20**	0.5	0.5	**20**	0.5	0.5	**20**	0.5	0.5
	Estimated kilograms infectious waste per bed per day:	**0.3**			**0.3**			**0.3**			**0.3**			**0.3**			**0.3**		
	Estimated kilograms unrecycled waste per bed per day:	**1.0**	0.5	0.5	**1.0**	0.5	0.5	**1.0**	0.5	0.5	**1.0**	0.5	0.5	**1.0**	0.5	0.5	**1.0**	0.5	0.5
	COLLECTION AND HANDLING																		
26	Are used syringe needles collected WITHOUT recapping?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
27	Is sharps waste collected in sharps containers or destroyed using needle destroyers?	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5	y	5	5
28	Are the sharps containers puncture-resistant and leak-proof? OR Are the needle destroyers approved under existing regulations or standards?	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
29	Are the sharps containers filled only 3/4th full? OR Are the needle-destroyers well maintained?	y	2.5	2.5	y	2.5	2.5	y	2.5	2.5	y	2.5	2.5	y	2.5	2.5	y	2.5	2.5
30	Are the sharps containers or needle-destroyers always available?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
31	Are the sharps containers or needle-destroyers properly placed such that they are easily accessible to personnel and located as close as possible to the immediate area where the sharps are used?	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	y	1.5	1.5	n	1.5	0
32	Do the health workers know what to do in the event of a needle-stick injury? OR Are the health workers familiar with the policy on needle-stick	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1

	injuries?																		
33	Are the plastic bags used for non-sharps infectious waste of good quality? OR Do you use specialized containers that are disinfected, cleaned and reused and do not require a plastic bags?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
34	Are plastic bags always available? OR are the specialized containers described in #33 always available?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
35	Are the bag holders or hard containers holding the plastic bags of good quality? OR Do you use specialized containers that are disinfected, cleaned and reused and do not require a plastic bags?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
36	Are the infectious wastes removed at least once a day?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
37	Do the waste workers know what to do if sharps or infectious waste is accidentally spilled? OR Are the waste workers familiar with the spill clean-up plans?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
	COLOR CODING AND LABELING																		
38	Does the healthcare facility use a system of color coding (or labeling) for different types of wastes?	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3
39	Are the colors of the waste containers consistent with the color coding? [or are the labels consistently used in the facility?]	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
40	Are the infectious waste bags colored or labelled in accordance with the policies or regulations?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
	POSTERS OR SIGNAGE																		
41	Are there posters or signs showing proper segregation of healthcare waste?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
	TRANSPORTATION INSIDE																		

	HEALTH ESTABLISHMENT																		
42	Is the waste transported away from patient areas and other clean areas?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
43	Is the waste transported in a closed, wheeled transport cart [or in a closed container]?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
44	Is the transport cart [or waste container] cleaned at least once a day?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
	STORAGE																		
45	Does the storage area meet the proper requirements?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
46	Are the storage areas for infectious and regular waste (trailers) kept clean?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
47	Are the wastes removed before the maximum allowable storage time is exceeded?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
	HAZARDOUS CHEMICAL, PHARMACEUTICAL AND RADIOACTIVE WASTE																		
48	Are hazardous chemical, pharmaceutical, and radioactive wastes segregated from infectious and general non-risk wastes? (Put Y in column C if the facilities does not generate these categories of waste.)	y	4	4	y	4	4	y	4	4	y	4	4	y	4	4	y	4	4
49	Does the healthcare facility have a plan for the treatment and disposal of hazardous chemical, pharmaceutical, and radioactive wastes? (Put Y in column C if the facilities does not generate these categories of waste.)	n	1	0	n	1	0	y	1	1	y	1	1	n	1	0	n	1	0
	TREATMENT AND DISPOSAL																		
50	Does the healthcare facility treat its infectious waste (either on-site or at an off-site treatment facility) before final disposal? If infectious waste is not treated before disposal, put N in column C of QUESTION #53b and skip to QUESTION #69.	y	25	25	y	25	25	y	25	25	y	25	25	y	25	25	y	25	25

51	Are laboratory cultures and stocks of infectious agents treated within the healthcare facility before being taken away from the facility? [Put Y if the hospital does note generate laboratory cultures]	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2	y	2	2
52	Is there a contingency plan for the treatment of infectious waste in the event that the treatment technology is shut down for repair?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
53a	*>> Does the healthcare facility treat its waste on-site? If yes, put Y in column C.*	y			y			y			y			y			y		
53b	*>> Does the healthcare facility treat its waste both on-site and using an off-site treatment center? If yes, put Y in column C and answer QUESTIONS #54-68.*	n			n			n			n			n			n		
	For facilities with on-site treatment:																		
	Describe the method of treatment used: VK-75 autoclave																		
54	Is the waste transported safely to the treatment area?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
55	Is the treatment area located in a place that is easily accessible to the waste worker but not accessible to the general public?	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5	y	0.5	0.5
56	Does the healthcare facility have a program of regular inspection and periodic maintenance of the treatment technology?	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3
57	Is the treatment system clean, operating properly, and well maintained?	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3	y	3	3
58	Does the treatment system destroy or mutilate sharps waste in order to prevent reuse?	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1
59	Does the healthcare facility use an approved non-incineration treatment technology such as an autoclave? If yes, put Y in column C and skip to QUESTION # 62.	y	6	6	y	6	6	y	6	6	y	6	6	y	6	6	y	6	6
62	Is anatomical waste buried safely in	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1	y	1	1

	concrete pits?																	
	WASTEWATER																	
69	Does the healthcare facility treat its wastewaste (liquid waste) before being released? OR Is the healthcare facility connected to a sanitary sewer that is linked to a wastewater treatment plant?	**y**	3	3	**y**	3	3	**y**	3	3	**y**	3	3	**y**	3	3	**y**	3	3
70	Does the treated wastewater from the healthcare facility meet international standards?	**n**	1	0	**n**	1	0	**y**	1	1	**y**	1	1	**n**	1	0	**n**	1	0
	TOTAL SCORE	**93**			**93**			**97**			**97**			**96**			**92**		

ANNEX E

Suggested Content of an Informational Brochure and Technical Paper on the HCWM Model

Suggested content of the informational brochure:

- Description of the situation before the project, highlighting the problems with burning, exposure to chemical disinfectants, problem with sharps and anatomical waste, complaints by neighbors
- Brief description of the HCWM model, highlighting needle destruction, reusable containers, autoclave, recycling of plastics and metals, and anatomical waste
- Schematic of the model, photos
- Quotes from several hospital directors and medical staff on the benefits of the new system
- Summary data on cost savings and revenues, reduction in needle-stick injuries and cuts
- Brief history of SDC projects in Kyrgyzstan
- Acknowledgement of SDC, SRC and RCIC/MOH

Suggested content of the technical paper:

- Abstract
- Introduction
- Literature review on the impacts of HCWM problems in developing countries including problems related to incineration of medical waste
- Review of existing resources on HCWM, including the WHO main reference document
- Methods: Investigation on the autoclave cycles; development of the basic scheme of HCWM; process used to integrate the new scheme into pilot hospitals; process of expanding to the rest of the country except Bishkek; survey questionnaire of hospital directors
- Results: Data on the autoclave tests; coverage of the HCWM system; results of the survey; economic data; data on occupational safety (needle-stick injuries and cuts); data on reduction of disinfectant use for HCWM; overall costs of the project
- Discussion: Analysis of the advantages and disadvantages of the system; areas for future work
- Conclusions
- Acknowledgements
- References

Procedure for Donning and Removing PPE

Procedures recommended by the U.S. Centers for Disease Control on putting on and taking off PPE for health professionals:

SEQUENCE FOR DONNING PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of precautions required; e.g., Standard and Contact, Droplet or Airborne Infection Isolation.

1. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist

2. MASK OR RESPIRATOR

- Secure ties or elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator

3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit

4. GLOVES

- Extend to cover wrist of isolation gown

USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn or heavily contaminated
- Perform hand hygiene

SEQUENCE FOR REMOVING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Except for respirator, remove PPE at doorway or in anteroom. Remove respirator after leaving patient room and closing door.

1. GLOVES
- Outside of gloves is contaminated!
- Grasp outside of glove with opposite gloved hand; peel off
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist
- Peel glove off over first glovet
- Discard gloves in waste container

2. GOGGLES OR FACE SHIELD
- Outside of goggles or face shield is contaminated!
- To remove, handle by head band or ear pieces
- Place in designated receptacle for reprocessing or in waste container

3. GOWN
- Gown front and sleeves are contaminated!
- Unfasten ties
- Pull away from neck and shoulders, touching inside of gown only
- Turn gown inside out
- Fold or roll into a bundle and discard

4. MASK OR RESPIRATOR
- Front of mask/respirator is contaminated — DO NOT TOUCH!
- Grasp bottom, then top ties or elastics and remove
- Discard in waste container

PERFORM HAND HYGIENE IMMEDIATELY AFTER REMOVING ALL PPE

Suggestions on Enhancing the Decomposition of Anatomical Waste in the Waste Pits

The decomposition of anatomical waste is carried out by microorganisms which metabolize organic waste as an energy source. Although the evaluator did not find studies specific to calcium hypochlorite, a few studies have looked at sodium hypochlorite and the inactivation of bacterial populations in water and soil. In one study, concentrations of sodium hypochlorite above 10 mg/L inhibited or killed bacteria in water and soil from a lake as shown by a decrease of respiratory volumes.[4] Another study looked at bacterial populations in the feet of healthy cattle. A 0.5% solution of sodium hypochlorite wiped in the interdigital space of the cattle and left to dry for 30 minutes resulted in an average decrease of 10^3 colony-forming units per area of digital

[4] Y Lu et al. "Effect on the respiration of bacteria in microcosm by the disinfectant of chlorine," *Wei Sheng Yan Jui 36*(2), 141-3, March 2007 (translated from Chinese).

space of mesophilic aerobic bacteria similar to those found in soil and the general environment.[5] It would not be unreasonable to assume that the use of calcium hypochlorite could destroy microorganisms that are needed for decomposition.

Decomposition can take place in aerobic or anaerobic conditions. When there is ample O_2, aerobic microorganisms break down organic waste to form CO_2, ammonia, water, heat, and a stable biomass product. Initially, mesophilic microorganisms thriving between 20-45^{0}C break down sugars, starches, and proteins. The heat they generate increases the temperature which eventually suppresses mesophilic activities and allow thermophilic bacteria, fungi, and actinomycetes thriving between 50-65^{0}C to breakdown fats and more resistant materials. Decomposition proceeds fastest under thermophilic conditions. It is in this stage that pathogenic bacteria can be inactivated. However, if temperatures exceed 65^{0}C, some desirable enzymes from beneficial microorganisms are inactivated. Eventually, the temperature of the mass declines but remains above 40^{0}C to continue degradation and mesophilic microorganisms are recolonized. A pH between 6.5 and 8.0 has been found to be ideal for the composting of pig carcasses.[6] Oxygen concentration should be > 5%. Various studies of composting of animal carcasses show the importance of carbon-to-nitrogen (C:N) ratios, 40-60% moisture, 30-50% porosity, bulk density between 474-711 kg/m^3, temperatures between 45-65^{0}C, addition of bulking agents to provide added nutrients and allow air pockets (increase porosity), and addition of microorganisms if the waste has been disinfected. The ideal C:N ratio for decomposition of animal carcasses ranges from 20:1 to 40:1 according to different researchers.[7] As a general rule, low C:N ratios lead to more ammonia and odors, while high C:N ratios result in lower temperatures and slower decomposition rates. C:N ratios of additives are shown in the Table below. Examples of bulking agents are litter, hay, sawdust, or straw which also serve as carbon sources. Adding compost, manure, or other sources rich in microorganisms could be very helpful.

Data on Potential Additives to Enhance Degradation[8]

Additive	C:N ratio	Porosity	Moisture	Degradability
Poultry manure	10	Poor	Moist	Good
Cattle manure	20	Medium	Medium	High
Horse manure	25	Good	Good	Good
Vegetable waste	13	Poor	Moist	Medium
Wheat straw	100	Good	Dry	Medium
Sawdust	200	Very good	Good	Excellent
Cardboard	200-500	Medium to poor	Very low	Very good
Wood chips	40-100	good	Too dry	Low
Garden waste	20-60	Good	Medium	Medium
Grass clippings	12-25	Poor	Moist	High
Food scraps	< 25	Very poor	High	Very high
Finished compost	30-50:1	Good	Good	Good

Anaerobic decomposition, on the other hand, entails hydrolysis (breaking down carbohydrates, proteins and fats into simple sugars, amino acids and fatty acids), acidogenesis or fermentation (further decomposition by

[5] LAF da Silva *et al.*, "The effects of sodium hypochlorite on mesophilic aerobic bacteria in the interdigital space of healthy cattle," *Israel Journal of Veterinary Medicine, 57*(2), 2002.
[6] J. Langston *et al.*, "Disposal of swine carcasses in Arkansas," Cooperative Extension Service report, University of Arkansas, Little Rock, Arkansas, 2002.
[7] See, for example, *Carcass Disposal: A Comprehensive Review*, US Department of Agriculture Animal & Plant Health Inspection Service, March 2004; and D. Rozeboom et al., Michigan Animal Tissue Compost Operational Standard, October 11, 2007.
[8] M. Dougherty, *Field guide to on-farm composting*, Report NRAES-114, Natural Resource, Agriculture, and Engineering Service, Cornell University, Ithaca, New York, 1999; D. Morse, "Composting animal mortalities," Minnesota Department of Agriculture, Agricultural Development Division, St. Paul, Minnesota, 2001.

enzymes, anaerobic bacteria or molds in the absence of oxygen to form volatile fatty acids, acetic acid, H_2 and CO_2), acetogenesis (further conversion of acidogenesis byproducts into other organic acids such as propionic and butyric acids, acetate, hydrogen and CO_2 by acetogenic bacteria), and methanogenesis (formation of methane and CO_2 from acetate and hydrogen/CO_2 by methanogenic bacteria).

If organic waste is placed in ideal aerobic conditions, thermophilic temperatures are reached within 24-36 hours. Under non-ideal conditions, hydrolysis and fermentation occur, the pH drops to between 3 and 5 due to the production of organic acids, and mesophilic conditions remain causing inefficient decomposition. One study involving composting of food mixed with wood shavings found that the addition of hydrated lime at the time of composting increased the pH and promoted thermophilic decomposition.[9] They found that the addition of hydrated lime at a rate of 6 grams per liter of waste significantly decreased the time it took for the waste to reach the thermophilic stage.

One could assume that anatomical waste has a low carbon, high nitrogen ratio similar to animal carcasses, about 5:1. For aerobic decomposition, one would need to add a good carbon source with low nitrogen to increase the C:N ratio and to act as a bulking agent with high porosity to allow air pockets. One should also add a good source of microorganisms to replace those destroyed by calcium hypochlorite. Adding bulking agents will decrease the capacity of the anatomical waste pits but they may speed up decomposition, which would reduce the volume by 20% to 50% based on data from the composting of pig and cattle carcasses.[10]

Calculations were conducted using a target C:N ratio of 20:1, a target moisture of 50%, using published %C and %N for different additives, typical moisture contents, bulk densities, and a maximum target bulk density of 474 kg/m^3 to achieve ideal conditions recommended for aerobic decomposition of animal waste. Estimates of the pH from the addition of 200 g calcium hypochlorite per kg of waste indicate that the pH in the waste pit will be sufficiently high to help neutralize organic acids. The results of the calculations (available upon request) are given below:

For each kilogram or for each liter of anatomical waste, add:
100 ml of water, 3 kg of sawdust, and 1 kg of horse manure, OR
250 ml of water, 2 kg of wheat straw, and 2 kg of horse manure, OR
100 ml of water, 4 kg of sawdust, and 1 kg of cattle manure, OR
100 ml of water, 2 kg of chopped or shredded cardboard, and 1 kg of horse manure

The evaluator recommends that RCIC experiment with combinations of these additives beginning with the ratios above as obtained from the theoretical calculations to see if this improves the decomposition of anatomical and placenta waste in the anatomical pits.

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[9] D. Cawthon, "Lime Speeds Thermophilic Decomposition of Food Residuals When Using In-Vessel Composting Technology," Department of Agricultural Science, Texas A&M University, no date.

[10] J. Kube, "Carcass disposal by composting," proceedings of the 35th Annual Convention of the American Association of Bovine Practitioners, Madison, Wisconsin, 2002; J. Langston et al., "Disposal of swine carcasses in Arkansas," Cooperative Extension Service report, University of Arkansas, Little Rock, Arkansas, 2002; and M. Looper, "Whole animal composting of dairy cattle," Dairy Business Communications, East Syracuse, New York, 2002.

Recommendations Related to Pressure Cookers as Autoclaves for Small Health Facilities

Recommendations on the use of pressure cookers as autoclaves for small rural facilities

1. The inside walls of the pressure cooker can be smeared with a light coat of cooking oil to prevent sticking of any soft plastics or coagulated blood in the waste. We have found that placing scrap paper on the bottom and sides also helps.
2. The pressure cooker is used as the container for healthcare waste, including cotton swabs, bandages, gloves, and plastic syringes after the needles have been removed by the needle destroyer. The biohazard symbol and a label can be drawn on the outside of the pressure cooker.
3. During use, the pressure cooker could be left open or loosely covered with the lid while healthcare waste is being accumulated.
4. When the container of the needle destroyer is 3/4th full, the needles can also be placed in an open metal can and put inside the pressure cooker for treatment.
5. At the end of the day, the technician weighs the pressure cooker and records the net weight of waste. A Class 1 color-changing indicator is placed on the waste and a prescribed amount of regular water is poured into the pressure cooker. The lid is then placed securely following the manufacturer's instructions.
6. The pressure cooker is placed on a stove and heated. Most pressure cookers can be heated on electric, gas, charcoal, wood, or others stoves; check with the manufacturer to make sure their cooker can be used with the heat sources available in the small facilities. As much as possible, a high efficiency stove should be used if charcoal or wood are used in order to minimize fuel and air pollution. Designs of locally manufactured high efficiency stoves can be found in the Internet.
7. Once the pressure cooker starts releasing a continuous flow of steam, the technician records the time and reduces the heat to maintain a moderate but steady steam flow. (An excessive flow of steam is a waste of energy and could result in evaporating all the water. If the pressure cooker loses all its water, the pressure cooker can be seriously damaged.)
8. After the prescribed duration is reached, the heat source is turned off and the pressure cooker is allowed to cool. The lid should only be opened when the cooker is no longer pressurized.
9. Treated wastes such as gloves, bandages, etc. can be discarded with regular waste. Treated needles can be collected in a can and buried later in a small waste pit. If the facility uses a lot of injections, the plastic syringe and needles can be collected, stored, and recycled.
10. The color-changing indicator is retrieved and placed in the journal as a record of treatment.

Recommendations on the selection of pressure cookers as autoclaves

1. The pressure cooker should be the right size. Estimate the daily rate of generation of infectious waste in small facilities. A pressure cooker with a capacity of 4 to 8 liters could be sufficient.
2. The pressure cooker should operate at the standard pressure of 1 atmosphere (1 bar or 100 kPa gauge pressure or about 15 psig). This corresponds to 121^{0}C for saturated steam at sea level. Some pressure cookers have two or more settings. At least one of those setting should correspond to the standard 1 atm pressure. If the pressure cooker has multiple settings, technicians should be instructed to use the setting corresponding to the standard 1 atm pressure.
3. Most pressure cookers release steam through a spring-loaded steam release valve or through a nozzle with a pressure regulating weight on top. These types of pressure cookers are easier to monitor. Some modern pressure cookers use rising indicators, pop-up indicators, or locking indicators to let the user know that the set pressure has been reached, and some of these do not show an obvious

release of steam. These modern types of pressure cookers are generally more expensive and may be harder to monitor.

4. Most pressure cookers have a hard rubber plug or overpressure relief valve to prevent excessive pressure in the pressure cooker. This is a good safety feature to have although it may add cost.
5. Some pressure cookers have an interlock to prevent the user from opening the lid while the cooker is under pressure. This is also a good safety feature but increases the price. Another option, which may be cheaper, is a quick-release valve that allows the user to let out any remaining steam in a known direction. Technicians should be instructed to point the pressure cooker in a safe direction and open the quick-release valve to make sure the cooker is depressurized before opening the lid.
6. Pressure cookers are made of stainless steel, heavy-gauge aluminum, or anodized aluminum. Some have copper-clad aluminum or silver-clad stainless steel at the bottom for even heat distribution. Handles are generally made of hard plastic such as phenolic resin. Some have an inside non-stick surface which adds costs. Pressure cookers use rubber gaskets (usually silicone) except for special cast aluminum pressure cookers which do not require gaskets. One would expect stainless steel pressure cookers be more durable. Spare gaskets and pressure regulating weights (if used) should be provided with the pressure cooker.

Recommendations on the testing of pressure cookers as autoclaves

1. Determine the amount of water needed for different durations of steaming. This is done by placing 0.5 liters of water (for pressure cookers with spring-loaded release valves) or 1 liter of water (for pressure cookers with nozzles), heating the pressure cooker, allowing the cooker to steam for 10 minutes (measured after the start of the steady flow of steam), removing the pressure cooker from the heat source, cooling it rapidly with cold water, and then measuring how much water remains. Record how much water was used up. Estimate the amount of water needed for 20 minutes of steaming, then repeat the experiment with more water, and calculate how much water was actually used up. As a general rule, pressure cookers with spring-loaded release valves use about 0.5 liters for every 15 minutes of steaming, while pressure cookers with nozzles use about 1 liter for every 20 minutes of steaming. Note that steaming duration should begin only after the pressure cooker releases a moderate steady flow of steam.
2. Prepare batches of surrogate medical waste to simulate a typical composition and amount of waste generated in a small facility. The amount of each batch of surrogate waste should be such that the pressure cooker is 3/4th full.
3. Wipe a small amount of cooking oil on the inside surface of the pressure cooker and lay scarp paper in the bottom. Place a batch of surrogate waste on top of the paper in the pressure cooker. Add enough water for 20 minutes of steaming. Bury thermocouples in the bottom, middle and top of the waste and heat the pressure cooker. (Unless a wireless thermocouple is used, the thermocouple wires may have to exit through the gasket. Monitor the change in temperature with time. Repeat the experiment with new batches of surrogate waste for 30 minutes, 40 minutes, etc. Determine the steaming duration that ensures that the coolest part of the waste reaches 121^0C for >12 minutes (assuming D value of 3 at 121^0C for G. *stearothermophilus*).
4. Repeat the experiment using microbiological indicators (G. *stearothermophilus* at a minimum 10^4 concentration) to validate the steaming duration for the pressure cooker.
5. Calculate different steaming times for different elevations. Because the boiling point of water decreases 1^0C for every 294 meters altitude, compute recommended steaming times for towns and cities at different elevations. To do this calculation, one has to know (1) the D value at a given steam temperature and (2) the z value of the bacterial spore used as provided by the vendor of the

microbiological indicator. Typical z values for *G. stearothermophilus* are between 7.6 to 8.3. See sample calculation below.

SAMPLE: Given *Geobacillus stearothermophilus* spores with a D value of 3 at 121^{0}C of steam (equivalent to 12 minutes for a 4 Log reduction at 121^{0}C) and z value of 8, calculate the time t needed to obtain a 4 Log reduction at an elevation of 800 meters.

$$t = 4\,x\,\frac{D_{121°C}}{10^{\frac{-A}{299(z)}}} = 4\,x\,\frac{3}{10^{-\frac{800}{299(8)}}} = 26\,minutes$$

Bishkek has an elevation of about 800 meters and would need about 26 minutes. On the other hand, Naryn has an elevation of 2044 meters, so a pressure cooker at the standard 1 atm pressure would need about 86 minutes of steaming in Naryn to achieve a 4 Log reduction of the bacillus spores with the D and z values given above.

Recommendations on Alkaline Hydrolysis Technology for Centralized Treatment of Anatomical Waste in Bishkek

Alkaline hydrolysis is a technology specifically designed to destroy anatomical waste and can be done in a large scale for centralized treatment. The equipment is basically an autoclave with a means to re-circulate the alkali solution or to stir the waste and alkali inside the chamber. Some technology vendors exist such as those shown below:

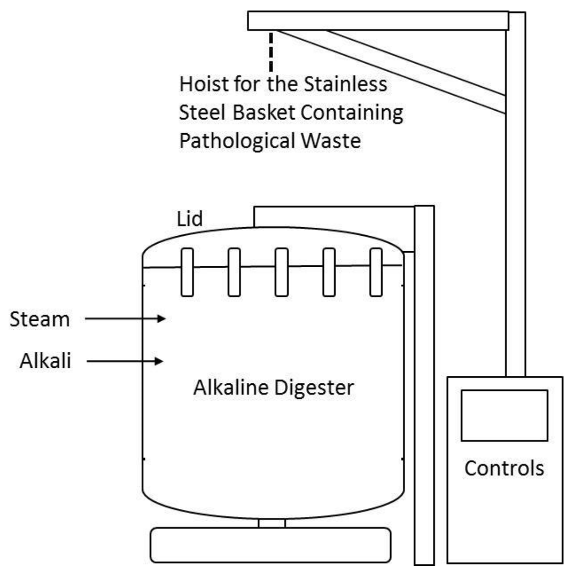
Name of Vendor	Physical Address	Telephone/Fax	Email	Website
Bio-Response Solutions, Inc.	1298 E. US Hwy 136, Suite A Pittsboro, IN 46167 USA	Tel.: +1 317-892-5200 Fax: +1 425-458-3194	info@bioresponsesolutions.com	http://bioresponsesolutions.com
BioSAFE Life Sciences	485 Southpoint Circle Building 200 Brownsburg, IN 46112 USA	Tel.: +1 317-858-8099 Fax: +1 317-858-8202	info@biosafelifesciences.com	www.biosafelifesciences.com
Progressive Recovery, Inc	700 Industrial Drive Dupo, IL 62239 USA	Tel.: +1 (618) 286-5000 Fax: +1 (618) 286-5009	dmarks@progressive-recovery.com	www.pri-bio.com
Peerless Waste Solutions, LLC	510 East 40th Street, Holland, MI 49423 USA	Tel.: 1-800-722-5722 Fax: +1 (616) 355-2890	sales@peerlesswaste.com	

The excerpt below is an introduction to alkaline hydrolysis technology taken from UNEP's *Compendium of Technologies for the Destruction of Healthcare Waste*[11]:

PROCESS DESCRIPTION

Alkaline hydrolysis or alkaline digestion is a process that converts animal carcasses, human body parts and tissues into a decontaminated aqueous solution. The alkali also destroys fixatives in tissues and various hazardous chemicals including formaldehyde, glutaraldehyde and chemotherapeutic agents. The technology uses a steam-jacketed, stainless steel tank and a basket. After the waste is loaded in the basket and into the hermetically sealed tank, alkali (sodium or potassium hydroxide) in amounts proportional to the quantity of tissue in the tank is added along with water. The contents are heated to between 110° to 127°C or higher while being stirred. Depending on the amount of alkali and temperature used, digestion times range from six to eight hours. Low-pressure alkaline digestion units are also available. They generally have longer operating times.

The technology is designed for tissue wastes including anatomical parts, organs, placenta, blood, body fluids, specimens, human cadavers and animal carcasses. The process has been shown to destroy prion waste. The byproducts of the alkaline digestion process are biodegradable mineral constituents of bones and teeth (which can be crushed and recovered as sterile bone meal) and an aqueous solution of peptide chains, amino acids, sugars, soaps, and salts. An excess of hydroxide could lead to a high pH of the liquid waste. Alkaline hydrolysis units have been designed to treat from 10 kg to 4500 kg per batch. The technology has been approved for the destruction of prion waste when treated for at least six hours.[12]



Alkaline Tissue Digester (BioSafe Engineering / WR[2])

[11] J. Emmanuel, *Compendium of Technologies for the Destruction of Healthcare Waste*, International Environmental Technology Centre, United Nations Environment Programme, Osaka, Japan, 2012.

[12] H. Thacker, "Carcass Disposal: A Comprehensive Review, Chapter 6: Alkaline Hydrolysis. National Agricultural Biosecurity Center. Kansas State University," 2004; "Updated opinion and report on: A treatment of animal waste by means of high temperature (150°C, 3 hours) and high pressure alkaline hydrolysis," Scientific Steering Committee, Health & Consumer Protection Directorate-General, European Commission, 2003.

TYPES OF WASTE TREATED

Alkaline hydrolysis is primarily intended for pathological waste, organs, tissues, cadavers, anatomical parts and contaminated animal carcasses. However, it can also treat biological stocks, cultures, liquid blood, body fluids, and other types of infectious waste. Moreover, the process has been shown to degrade aldehydes, such as formaldehyde and glutaraldehyde waste which are commonly used in healthcare and research settings and may be found in pathological and animal wastes. Many chemotherapeutic agents, such as Cyclophosphamide, Chlorambucil, Melphalan, Uracil Mustard, Daunomycin, etc., are also destroyed by alkaline hydrolysis.[13]

The treatment system should not be used for wastes containing aluminum, tin, zinc, magnesium, copper, or galvanized iron (as these metals could react to form hydrogen gas), as well as concentrated acids, flammable liquids and organohalogen compounds (especially trichloroethylene), and nitromethane and other similar nitro compounds.

RANGE OF CAPACITIES

Alkaline hydrolysis technologies can handle from 15 to 4500 kg per load, with treatment cycles ranging from 3 to 8 hours depending on temperature, pressure, alkali concentration, and mixing efficiency.

PATHOGEN DESTRUCTION

Kaye and co-workers tested the efficacy of alkaline hydrolysis of on animal carcasses (pigs, sheep, rabbits, dogs, rats, mice, and guinea pigs) along with the following microbiological indicator organisms: *Staphylococcus aureus, Mycobacterium fortuitum, Candida albicans, Bacillus subtilis, Pseudomonas aeruginos, Aspergillus fumigatus, Mycobacterium bovis* BCG, MS-2 bacteriophage, and *Giardia muris*.[14] No growth was reported for any of the indicator organisms, corresponding to $\log_{10}$ reductions ranging from 7 to 9 except for *Giardia* and *Aspergillus fumigatus*. Aspergillus had a reduction corresponding to about 3 $\log_{10}$. Intact Giardia cysts could not be detected except for small fragments of what appeared to be cyst wall.

EMISSIONS AND BY-PRODUCTS

Alkaline hydrolysis converts fats in human or animal parts into soaps. Tissues, organs and body parts are decomposed into peptides, amino acids, soaps, salts, sugars, and ammonia. When the process is complete, a soapy ammonia odor can be detected in the immediate vicinity of the unit and is generally dissipated by natural ventilation.

As the alkaline digestion process decomposes pathological waste into liquid (except for calcium and any metals, plastics or rubber in the waste), the effluents from an alkaline hydrolysis unit can range from 100 liters per load for a 15 kg unit to 24,000 liters per load for a large 4500 kg unit. The effluent has a pH of about 11 and generally has to be discharged at a slow rate, diluted or neutralized by bubbling CO_2 depending on local regulations. Tests of the effluent showed relatively high biological oxygen demand (BOD5), chemical oxygen demand, suspended solids, organic nitrogen and ammonia but were within effluent discharge limits.[15]

The solid residues of alkaline hydrolysis are calcium from friable bone fragments, and any plastics, non-reactive metals, rubber, or ceramics. Since the solid residues are sterile, they can be recovered. Calcium from alkaline hydrolysis has been used as a soil conditioner.

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[13] Technical Data Monograph, Waste Reduction by Waste Reduction, Inc., Indianapolis, Indiana, no date.
[14] "Efficacy of Alkaline Hydrolysis as an Alternative Method for Treatment and Disposal of Infectious Animal Waste," G.I. Kaye, P.B. Weber, A. Evans, and R.A. Venezia, Contemporary Topics (American Association for Laboratory Animal Science) 37(3), 43-46 (1998).
[15] Data provided to the author by WR^2, Indianapolis, Indiana in 2005.

The by-products of low pressure alkaline hydrolysis units are generally in the form of a slurry with hard bone fragments. The slurry coagulates and forms a hard solid when it cools.

INSTALLATION REQUIREMENTS

The typical installation requirements are:

- Enclosure and foundation
- Sewer
- Water supply
- Steam (unless an electric or gas-fired steam generator is used)
- Electrical connections
- Air
- Phone line.

Suggestions Related to Hazardous Chemical Wastes in Hospitals

The following is information related to pharmaceutical waste, cytotoxic waste, chemical waste, and radioactive waste. They are taken from the latest edition of the World Health Organization's reference guidelines.[16] References and more details can be found in the original document.

Pharmaceutical waste

Pharmaceutical waste can be minimized by good inventory control or a "just-in-time" inventory strategy; by purchasing drugs in the dosages routinely administered; by monitoring expiration dates so that existing stock is used before newly arrived supplies (also known as good "stock rotation"); by replacing pre-packaged unit dose liquids with patient-specific oral doses; and other good management practices (Practice Greenhealth, 2006).

Before treatment, pharmaceutical waste should be labelled and sorted using proper personal protection equipment. Pharmaceutical waste can be sorted according to dosage form (solids, semi-solids, powders, liquids or aerosols) or by active ingredient depending on the treatment options available. Special consideration is needed for controlled substances (e.g. narcotics), anti-infective drugs, antineoplastic and cytotoxic drugs, and disinfectants.

Several options exist for small quantities of pharmaceutical waste:

- return of expired pharmaceuticals to the donor or manufacturer;
- encapsulation and burial in a sanitary landfill;
- chemical decomposition in accordance with the manufacturer's recommendations if chemical expertise and materials are available;
- dilution in large amounts of water and sewer discharge into a sewer for moderate quantities of relatively mild liquid or semi-liquid pharmaceuticals, such as solutions containing vitamins, cough syrups, intravenous solutions and eye drops.

Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses. Their disposal in this way is not acceptable due to their likely toxicity to discharge even small quantities of pharmaceutical waste into slow-moving or stagnant waterbodies (WHO, 1999).

[16] A. Prüss, J. Emmanuel, P. Rushbrook, R. Zghondi, R. Stringer, U. Pieper, W. Townend, S. Wilburn, Y. Chartier, *Safe management of wastes from health-care activities*, Second Edition, World Health Organization, Geneva, Switzerland, 2013.

For large quantities of pharmaceutical waste, the options available include:

- encapsulation and burial in a sanitary landfill;
- incineration in kilns equipped with pollution-control devices designed for industrial waste and that operate at high temperatures;
- dilution and sewer discharge for relatively harmless liquids such as intravenous fluids (salts, amino acids, glucose).

Some emerging technologies include large-scale ozonation and decomposition using iron-tetraamidomacrocyclic ligand (Fe-TAML) peroxide catalysis. These technologies should be evaluated carefully, because many do not have an established record treating health-care-related pharmaceutical waste.

Cytotoxic waste

Chemotherapeutic waste, including cytotoxic, antineoplastic and cytostatic waste, should first be minimized by careful segregation, purchasing optimal drug quantities, using proper spill containment and clean-up procedures, and substituting environmentally persistent drugs with degradable drugs where possible.

Cytotoxic waste is highly hazardous and should never be landfilled or discharged into the sewerage system. Disposal options include:

- return to the original supplier
- incineration at high temperatures
- chemical degradation in accordance with manufacturers' instructions.

Full destruction of all cytotoxic substances may require incineration temperatures up to 1200 ºC and a minimum gas residence time of two seconds in the second chamber. The incinerator should be equipped with gas-cleaning equipment. Incineration at lower temperatures may release hazardous cytotoxic vapours into the atmosphere. Incineration in most municipal incinerators, in single-chamber incinerator or by open-air burning, is inappropriate for the disposal of cytotoxic waste.

Chemical degradation methods, which convert cytotoxic compounds into non-toxic/non-genotoxic compounds, can be used for drug residues and for cleaning contaminated urinals, spillages and protective clothing (IARC, 1983; IARC, 1985). These methods are not used widely and require special knowledge. They are not appropriate for treating contaminated body fluids. The International Agency for Research on Cancer (IARC) Unit of Gene-Environment Interactions can be contacted for further information.

It should be noted that neither incineration nor chemical degradation currently provides a completely satisfactory solution for treating waste items, spillages or biological fluids contaminated by antineoplastic agents. Until such a solution is available, hospitals should exercise the utmost care in the use and handling of cytotoxic drugs.

Where neither high-temperature incineration nor chemical degradation methods are available, and where exportation of cytotoxic wastes for adequate treatment to a country with the necessary facilities and expertise is not possible, encapsulation or inertization may be considered as a last resort. Alkaline hydrolysis and some of the emerging technologies may have useful applications in the destruction of cytotoxic waste.

Chemical waste

Chemical safety and hazardous chemical waste management should ideally be the subject of a national strategy with an infrastructure, cradle-to-grave legislation, competent regulatory authority and trained personnel.

Improving the management of chemical waste begins with waste minimisation. Minimisation options include:

- substituting highly toxic and environmentally persistent cleaners and solvents with less toxic and environmentally friendly chemicals

- using minimum concentrations where possible
- ensuring good inventory control (i.e. "just-in-time" purchasing)
- designing storage areas well
- integrating pest management
- keeping disinfecting trays covered to prevent loss by evaporation
- developing spill-prevention and clean-up procedures
- recovering solvents using fractional distillation.

Where allowed by local regulations, non-recyclable, general chemical waste, such as sugars, amino acids and certain salts, may be disposed of with municipal waste or discharged into sewers. However, official permission from the appropriate authority may be required and the types and quantities of material that can be discharged may be limited. Generally, conditions for discharge may include restrictions on pollutant concentrations, content of suspended solids, temperature, pH, and, sometimes, rate of discharge. Unauthorized discharge of hazardous chemicals can be dangerous to sewage treatment workers and may adversely affect the functioning of sewage treatment works. Petroleum spirit (volatilizes to produce flammable vapours), calcium carbide (produces flammable acetylene gas on contact with water) and halogenated organic solvents (many compounds are environmentally persistent or ecologically damaging) should not be discharged into sewers.

It is not possible to dispose both safely and cheaply large quantities of hazardous chemical waste without using sophisticated treatment methods. The appropriate means of storage and disposal is dictated by the nature of the hazard presented by the waste. The following measures are suggested:

- hazardous chemical wastes of different composition should be stored separately to avoid unwanted chemical reactions;
- hazardous chemical waste should not be discharged into sewerage systems;
- large amounts of chemical waste should not be buried, because they may leak from their containers, overwhelm the natural attenuation process provided by the surrounding waste and soils, and contaminate water sources;
- large amounts of chemical disinfectants should not be encapsulated, because they are corrosive to concrete and sometimes produce flammable gases.

An option for disposing of hazardous chemicals is to return them to the original supplier, who should be equipped to deal with them safely. Where such an arrangement is envisaged, appropriate provisions should be included in the original purchase contract for the chemicals. Preferably, these wastes should be treated by a specialist contractor with the expertise and facilities to dispose safely of hazardous waste. Use of certain products for non-medical purposes may also be considered; for example, use of outdated disinfectants to clean toilets is often acceptable.

Photochemicals should be collected separately, because there is a recovery value from silver compounds contained in the solutions. Recovery of silver from photoprocessing wastewater may be possible using cation exchange, electrolytic recovery or filtration. Spent fixing bath and developing bath solutions should be carefully mixed and the neutralized solution stored for a minimum of one day. The mixture should be diluted (1:2) and very slowly poured into a sewer.

Radioactive waste

The treatment and disposal of radioactive waste is generally under the jurisdiction of a nuclear regulatory agency, which defines clearance levels and waste classifications according to activity levels and half-lives of the radionuclides present. A radioactive waste-management plan should include a programme of waste minimisation. The primary methods of waste minimisation are source reduction, extended storage for decay of radioactivity, and substitution with a non-radioactive alternative. Source reduction strategies include limiting the quantity of radioactivity purchased, and laboratory procedures that reduce the volume of waste generated. Substitution means replacing long-lived radionuclides with shorter half-life radionuclides or non-radioactive substitutes where possible.

UNSEALED SOURCES — SHORT-LIVED RADIONUCLIDES

Three disposal methods are possible for low-level radioactive waste:

- "decay in storage", which is the safe storage of waste until its radiation levels are indistinguishable from background radiation; a general rule is to store the waste for at least 10 times the half-life of the longest lived radionuclide in the waste (more information can be found in Chapter 7);
- return to supplier;
- long-term storage at an authorized radioactive waste disposal site.

Containers used for storing radioactive waste should be clearly identified (marked with the words "RADIOACTIVE WASTE" and the radiation symbol) and labelled to show the activity of the radionuclide on a particular date, period of storage required, origin of the waste, surface dose rate on a particular date, quantity and responsible person. Facilities should segregate radioactive waste according to the length of time needed for storage: short-term storage (half-lives less than 60 days) and long-term storage (half-lives more than 60 days. Decayed but infectious waste should be disinfected before subsequent treatment and disposal.

A health-care facility should ensure that radionuclides are not released to the environment unless:

- the radioactivity released is confirmed to be below the clearance levels or
- the radioactivity of liquid or gaseous effluents is within limits authorized by a regulatory authority.

SEALED SOURCES AND LONG-LIVED RADIONUCLIDES

Sealed sources, long-lived radionucleotides and spent sources (e.g. from X-ray equipment) should be returned to the producer or supplier of their original form. Health-care facility planning to import a sealed source with a radioactivity greater than 100 MBq should require the supplier to accept the source back after expiration of its useful lifetime and within a year after a notification is made. If this is not possible, the waste must be stored in an approved long-term storage facility in keeping with international guidelines. Whether the waste is returned or stored in a long-term facility, the waste should first be "conditioned" to make it suitable for handling, transportation and storage. Conditioning may involve immobilisation in concrete, securing the waste in suitable containers and providing additional packaging.

A SUMMARY OF FURTHER PRACTICES WITH RADIOACTIVE HEALTH-CARE WASTES

Disposable syringes containing radioactive residues should be emptied in a location designated for the disposal of radioactive liquid waste. Syringes should then be stored in a sharps container to allow decay of any residual activity, before normal procedures for disposal of syringes and needles are followed.

It is not appropriate to disinfect radioactive solid waste by wet thermal or microwave procedures.

Solid radioactive waste, such as bottles, glassware, and containers, should be destroyed before disposal to avoid reuse by the public.

The drains that serve sinks designated for discharge of radioactive liquids should be identified. If repairs become necessary, radiation levels should be measured when the drain or sewer is opened up and appropriate precautions should be taken to avoid unacceptable radiation exposures.

Higher-level radioactive waste of relatively short half-life (e.g. from iodine-131 therapy) and liquids that are immiscible with water, such as scintillation counting residues and contaminated oil, should be stored for decay in marked containers, under lead shielding, until activities have reached authorized clearance levels. Water-miscible waste may then be discharged to the sewer system and immiscible waste may be disposed of by the methods recommended for large quantities of hazardous chemical waste.

Radioactive waste resulting from cleaning-up operations after a spillage or other accident should be retained in suitable containers, unless the activity is clearly low enough to permit immediate discharge. If excessive activity enters the sewer accidentally, a large volume of water should be allowed to flow to provide dilution to about 1 kBq per litre. The relevant government agency must be informed urgently if radioactive waste in excess of the permitted amounts has been discharged to sewers, the atmosphere or otherwise into the environment. After the emergency period, the activity of the resulting waste should be assessed and the relevant regulators informed of the circumstances that gave rise to the incident. It is important to learn from such incidents and working methods changed to avoid it happening again.

It is not usually necessary to collect and confine patients' excreta after diagnostic procedures, although ordinary toilets used by such patients should be checked regularly for accumulation of radioactive contamination. In the case of therapeutic procedures involving radionuclides, hospital toilets must be checked for radioactive contamination after each use by patients, unless every patient has an individual toilet. Some countries require the use of separate toilets equipped with delay tanks, also called holding tanks, or special treatment systems for patients undergoing radiotherapy.

A potential option for pharmaceutical, cytotoxic (chemotherapeutic) and some chemical waste is a technology being developed by a UNDP GEF Project in Argentina. Instead of incineration, the technology uses a Fenton reaction which involves mixing hydrogen peroxide and ferrous sulfate to produce a highly reactive free radical OH°:

$$H_2O_2 + Fe^{+2} \rightarrow Fe^{+3} + OH^{-} + OH^{\circ}$$

The Fenton reaction has been shown to destroy a wide range of chemotherapeutic agents. As the technology is developed, more information can be found in www.gefmedwaste.org.

Mercury

With regards to mercury, one recommendation is for the Kyrgyz Republic to sign and ratify the Minamata Convention on Mercury.[17] The guidances, slide presentation, and notes listed below, developed by the UNDP GEF Project on Global Healthcare Waste, may be of value. These resources can be found in www.gefmedwaste.org.

- Notes on Selecting Mercury Reduction Activities in Healthcare Facilities
- Narrated PowerPoint Presentation – "Mercury: Sources and Health Effects"
- Guidance on Reducing Mercury Release from Dental Facilities
- Guidance on Clean-Up, Transport and Interim Storage of Mercury from Healthcare Facilities
- Monitoring of Mercury Levels in Ambient Air in Healthcare Facilities
- Comparative Evaluation of Non-Mercury Thermometers
- Guidance on Technical Specifications for Non-Mercury Devices
- Replacement of mercury thermometers and sphygmomanometers in health care (WHO technical guidance)
- Guidance on Maintaining and Calibrating Non-Mercury Clinical Thermometers and Sphygmomanometers.

[17] http://www.mercuryconvention.org/Convention/tabid/3426/Default.aspx