Data & Policy Program

Data-driven analysis to guide sustainable materials management

Household Needles in Municipal Solid Waste (MSW)

Policy, Controls, and Material Recovery Facility (MRF) Safety

Publication date: 2018

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EREF's Data & Policy Program was developed as part of the foundation's effort to expand its mission to advance knowledge and education for sustainable solid waste management. The primary objective of the Data & Policy Program is to aggregate and analyze solid waste data. The program also provides valuable experience to undergraduate and graduate students who assist in data gathering and analysis.

Environmental Research & Education Foundation™

Lighting a path to sustainable waste management practices

3301 Benson Drive, Suite 101

Raleigh, North Carolina 27609

Phone: 919.861.6876

E-mail: IRP@erefdn.org

Web: www.erefdn.org

Corresponding Authors: Bryan F. Staley, Ph.D., P.E. and Debra L. Kantner. Questions regarding the content of this report may be directed to the corresponding authors at the e-mail address noted above.

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Cover photo: Syringe observed in the plastics line at a Material Recovery Facility (MRF) processing MSW recyclables.

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EXECUTIVE SUMMARY

Household generated needles and sharps have historically been found in residential waste streams, presenting a risk of needlestick injury (NSI) to waste management personnel. Currently, data documenting the extent and rate of needlestick and related injuries is sparse but it has been suggested that NSIs present a notable risk to waste industry workers. This is especially true in Material Recovery Facilities (MRFs), where activities such as picking lines put employees in direct contact with sharps when manually moving or sorting waste materials. There are concerns that NSIs will increase in the coming years due to factors such as an aging population, home management of increasingly prevalent medical conditions (e.g. diabetes, migraine), confusion surrounding proper disposal, and lack of access to take-back programs.

Disposal of loose needles or other sharps in the MSW stream is never considered proper disposal. However, proper disposal is not universally defined. States set individual policy and guidance on accepted methods for needle disposal. Most states allow for the disposal of containerized household needles (CHN) in curbside residential waste. Four states (CA, MA, OR, and WI) have banned the practice.

Objectives

- Summarize current policy and practices pertaining to the safe disposal of home-health needles and other sharps
- Inventory needlestick incidences at MRFs to estimate total needlestick injuries and estimate incidence rates for MRF workers in the U.S. and Canada
- Quantify the relative importance of needlesticks with respect to other risks within the waste industry
- Document current practices and activities that may be related to increased or decreased needlesticks

Survey results of U.S. and Canadian MRFs indicate needles are routinely observed in the recycling stream. Over half of the facilities (53%) reported seeing needles daily or a few times per week. Most commonly, needles were seen on the plastics line. Fifty-six percent of facilities reported one or more NSI injuries had occurred during 2016. Survey results indicate the NSI rate for MRF workers is 2.7 per 100 full-time equivalent (FTE). The rate is higher when only picking line workers are considered, with a NSI rate of 3.9 per 100 FTE. The Bureau of Labor Statistics estimates an overall illness and injury incidence rate of 6.0 per 100 FTE at U.S. MRFs, suggesting that NSIs comprise 45% of total reportable incidences. Of incidences with day(s) away from work, NSIs comprise 0.1% of the total at U.S. MRFs.

Based on these findings, it is estimated that between 781 and 1,484 NSIs may occur each year in the United States, resulting in up to $2.25M in direct costs for treatment, prophylaxis, and monitoring after NSIs occur.

BACKGROUND, DEFINITIONS, AND OBJECTIVES

Definitions and Background. Medical sharps include needles, syringes, lancets, auto injectors (including epinephrine and insulin pens), infusion sets, and connection needles/sets. Household generated needles and sharps have historically been found in residential waste streams, presenting a risk of needlestick injury (NSI) to waste management personnel (Lawitts, 2002). The key concern with NSIs is that of occupational exposure to blood and bodily fluid. NSIs present a pathway for the transmission of bloodborne illnesses, the most common of which are Human Immunodeficiency Virus (HIV), Hepatitis B (HBV), and Hepatitis C (HCV) (CDC, 2004). When exposed to these viruses through NSIs, the risk of infection ranges from 0.3% to 30% (Table 1).

Table 1. Risk of Infection from Needlestick Injuries[a]

Disease/Virus	Post-Exposure Risk of Infection[b]
Human immunodeficiency virus (HIV)	0.3%
Hepatitis B (HBV)	6 – 30%
Hepatitis C (HCV)	1.8%

[a]From CDC, 2004; NIOSH, 2000
[b]Risk from single exposure via needlestick injury

NSI-related legislation, such as the Needlestick Safety and Prevention Act, typically focuses on healthcare facilities where workers routinely encounter needles and sharps (e.g. lancets, syringes, infusion sets) during patient care. Within a healthcare setting, policies and procedures are in place to manage sharps properly but injuries can still occur from improper needle disposal. Based on historical data from the Centers for Disease Control and Prevention's National Surveillance System for Healthcare Workers (NaSH), 8% of healthcare facility NSIs from June 1995 through December 2007 were due to improper disposal (CDC, 2011) (Figure 1).

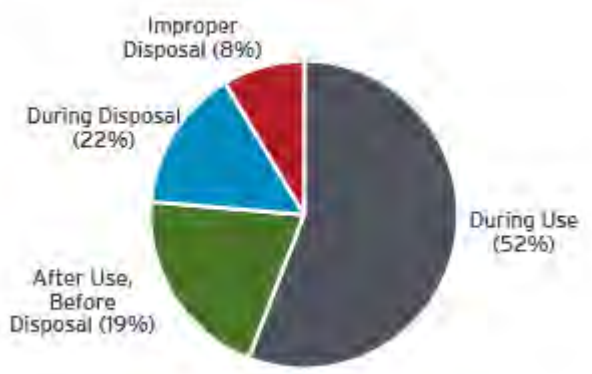
Figure 1. Needlestick Injuries at Healthcare Facilities (1995–2007)

During Use (52%)
- Insertion or Removal of Needle (27%)
- Collision with sharp or worker (10%)
- Other or Unknown (15%)

After Use, Before Disposal (19%)
- During Clean-Up (9%)
- Recap of Needle (5%)
- Activation of Safety Feature (5%)

During Disposal (14%)
- During disposal (11%)
- In transit to disposal (3%)

Improper disposal (8%)



Adapted from CDC, 2011

In addition to potential exposure from healthcare facility waste (Figure 1), waste management personnel can also be exposed to needles and medical sharps in the residential household waste stream. An estimated 13.5 million people in the U.S. use needles outside of healthcare facilities, primarily by self-injecting medication (CSCND, 2011). This is equivalent to over 7.5 billion injections occurring outside of healthcare facilities, with the subsequent sharps disposal not subject to the strict healthcare facility regulations (Gold, 2011). While household needles may be discarded in a sharps container, a survey by UltiCare (2018) suggests that up to 95% of household sharps are discarded loose and unprotected in the residential MSW stream. This presents a pathway of exposure for municipal solid waste (MSW) workers during waste collection, processing, and disposal activities.

There is concern within the waste industry that the frequency of needles in the MSW stream and related NSIs have increased in recent years. The number of needles in household garbage tripled over the decade from 2001 to 2011 (CSCND, 2011). Trends and factors that may contribute to further increase in needles and NSIs include:

- An increase in home-health services, due largely in part to an aging U.S. population (Landers et al., 2016);
- The growing opioid epidemic, and resulting increase in needle use (Conklin, 2018; Mott, 2018);
- Lack of access to take-back programs for sharps disposal (e.g. needle drop-off);
- Confusion or lack of education over proper sharps disposal in the home;
- Light-weighting of consumer plastic packaging used for at-home needle disposal (Arakawa and Ebato, 2014); and
- Potential use of soda cans or milk bottles as a repository for used household needles which, coupled with efforts to increase recycling, may result in these materials being placed in recycling bins.

Currently, data documenting the extent and rate of needlestick and related injuries is sparse. Given the importance of worker safety, more data quantifying the risk of needlestick injuries is needed to better understand the potential hazards related to needles and other healthcare sharps in residential waste streams. This is especially true at material recovery facilities (MRFs) where activities such as picking lines put employees in direct contact with improperly disposed sharps when manually moving or sorting materials along the conveyor.

The objectives of this report are to:

1) Summarize current policy and practices pertaining to the safe disposal of home-health needles and other medical sharps
2) Inventory needlestick incidences at MRFs and reported circumstances, in an effort to estimate the total number of needlestick injuries in the U.S. and Canada
3) Quantify the relative importance of needlestick injuries with respect to other risks in the waste industry
4) Document current practices and activities that may be related to increased or decreased needlestick injuries

Disposal Guidance for U.S. States. Disposal of loose needles or other sharps in the MSW stream (i.e. placed directly into a trash can and not aggregated into a container) is never considered appropriate (FDA, 2018); however, proper disposal is not universally defined. No federal law exists for disposal of household sharps. States set individual policy and guidance on accepted methods for needle disposal and their hierarchy of preference. Most states allow for the disposal of containerized household needles (CHN) in residential waste, under the following generalized guidance:

1) A sharps container, or other rigid container, is used to collect needles. The most commonly provided example is rigid opaque plastics (e.g. laundry detergent and bleach containers).
2) The container should be disposed of when it is 3/4 full. It should be sealed with its lid and duct tape. It should be labeled "DO NOT RECYCLE".
3) The plastic container can be placed in household trash, and must never be recycled.
4) Sharps that retract or are very small should be disposed of like all other sharps.
5) Confirm with local government/hauler that disposal under this guidance is allowed.

Adapted from CSCND, 2017

Guidance documents were identified for 49 states and Washington D.C., with specific focus on conditions for disposal of CHN with residential waste. Guidance documents were identified through the state environmental and health departments as well as national databases for household sharps information (NeedyMeds, 2017; UltiCare, 2018).

Four states (CA, MA, OR, and WI) ban the disposal of CHN within the residential MSW stream. In the remaining states and Washington D.C., the practice is legal though often discouraged. Cities and counties within the remaining states may ban the practice (e.g. Seattle, WA; many counties in FL), and residents are typically encouraged by state agencies to confirm proper disposal methods in their respective local jurisdiction. Of states allowing CHN co-disposal in the residential stream, notable differences in guidance were observed for:

- recommended container materials,
- labeling requirements,
- max fill levels,
- pre-treatment, and
- stated preference or hierarchy for management.

Container Material. The U.S. Food & Drug Administration (FDA) evaluates sharps containers for both safety and effectiveness to reduce the risk of needlestick injuries (NSIs). FDA-cleared sharps disposal containers are considered to be the safest option for household sharps storage and disposal. As mentioned previously, guidelines recommend using thick, leak-proof, rigid plastic containers with a tight fitting lid (e.g. plastic laundry detergent bottle, empty bleach bottle) if a sharps container is unavailable. In some cases, state policies and guidance include examples of other suitable container types in addition to laundry detergent or bleach bottles. In some cases, states also provided examples of inappropriate or forbidden container types.

The number of states recommending or forbidding additional container types are catalogued in Table 2. Each of these example container types is commonly considered recyclable. Concern exists that the use of recyclable containers (e.g. soda cans or milk bottles) to manage used household needles, coupled with efforts to increase recycling, result in these materials increasingly being placed in or moved to recycling bins.

Table 2. Additional Container Types Referenced in Containerized Household Needle (CHN) Disposal Guidance

Container Type	# States Recommending	# States Forbidding	Total # References
PET soda bottle	9	8	17
Metal coffee can	10	5	15
Glass container	0	14	14
Aluminum cans	0	3	3

Of particular interest is PET soda bottles, given a similar number of states recommend (9 states) and forbid (8 states) the use of these bottles for sharps disposal. Additionally, residents unfamiliar with plastic types and/or resin codes may not instinctively differentiate between rigid opaque plastic (e.g. laundry container, bleach container) and flexible PET (e.g. clear soda bottle) packaging.

The recommendation of soda bottles can be seen as concerning given the trend of manufacturing containers with less resin (i.e. "light-weighting"). In response to increasing needlestick rates in Japan, a 2014 study tested penetration of 5 commonly used types of needles in both traditional and light-weighted PET bottles (Arakawa and Ebato, 2014). The study found that the light-weighted eco-bottles presented an increased needlestick risk due to significantly higher rate of needle protrusion. Light-weighting has also been observed in rigid plastic laundry bottles, which are the most common example of suitable CHN container (Smith and Tonjes, 2016). As both flexible and rigid plastic packaging continues to be light-weighted in the U.S., there may be a corresponding increase in needlestick injuries, especially in states that include clear PET (e.g. soda bottle) as a suitable container for household sharps disposal.

Labeling. Seventy-percent of states provides requirements related to the labeling of household sharps containers: 32 states with requirements for labelling of the container and 1 state (Nebraska) with the requirement that residents "do not mark or label the container in such a way as to divulge the contents" (NDEQ, 2016). For those with labeling requirements, the purpose of labels were to indicate the contents (e.g. "Household Sharps", "Needles", "Biohazard") and to discourage recycling of the container (e.g. "DO NOT RECYCLE"). In D.C., labeling requirements specify the use of red ink. In two states (South Carolina and Vermont), residents are instructed to use state-provided labels or stickers to identify sharps containers (Figure 2).

Figure 2. Example State-Provided Labels for Containerized Household Needle (CHN) Disposal[a]

[a]Top: Vermont DEC (2018); Bottom: SCDHEC (2017)

Max Fill. Overfilling sharps containers increases the risk of NSIs. For this reason, the FDA recommends that containers are not filled more than three-quarters (3/4) full (US FDA, 2018b). Of the 46 state recommendations identified for containerized needle disposal, half (23 policies) include guidance on container fill level. Most commonly (30%), states specified that container should be disposed of when "full" or "after filled" (Table 3). Other specified fill levels were at one-half (7%), two-thirds (4%), and three-quarters (2%). It is worth noting that only one state (South Carolina) provided guidance consistent with the FDA recommended fill level of three-quarters full (Table 3).

Table 3. Household Sharps Container Guidance for Fill Level

Specified Fill Level	# of CHN Co-Disposal Policies	% of Total CHN Co-Disposal Policies
Guidance Provided	23	50%
1/2 Full	*3*	*7%*
2/3 Full	*2*	*4%*
3/4 Full[a]	*1*	*2%*
Full	*14*	*30%*
Do Not Overfill	*3*	*7%*
No Guidance	23	50%
Total	**46**	**100%**

[a]U.S. Food & Drug Administration recommendation is 3/4 full.

Pre-Treatment. Ten states include at-home pre-treatment of CHN in their disposal guidance. In most of these instances (90%), the additional treatment is a disinfection step immediately before disposal of the full container (i.e. 20 minute soak in 10:1 dilution of bleach). In one state (Arizona), encapsulation is recommended by adding quick drying cement, plaster or similar material and allowing it to dry fully before placing in a household waste container.

Preference in Disposal Options. Of the policies permitting CHN co-disposal in the residential stream, roughly one-quarter (11 states) specify that the practice is the least preferred or last resort option for household needle management. Typically, flyers and documents in these states acknowledge the hazard it presents to waste management workers and seek to educate residents on preferred disposal options. These may include drop-off sites, mail-in services, syringe exchange programs, or special waste pick-up. More information on these options is provided in the section "Strategies for Addressing Needles in MSW Streams".

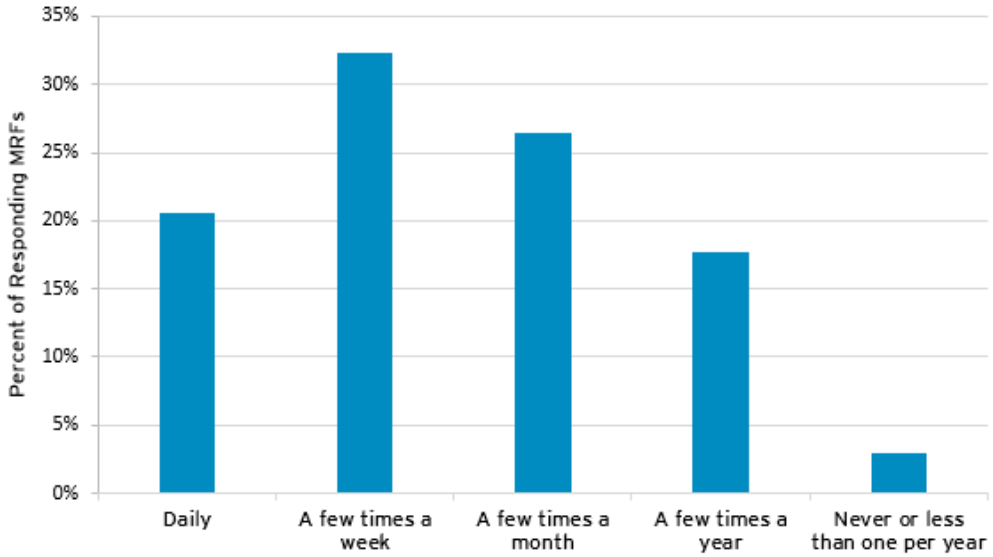
Current State of Awareness at MRFs. Although needlestick injuries (NSIs) have historically been noted in the waste management sector, statistics on the number and/or rate of NSIs have not been widely published. To estimate recycling-related NSI rates, EREF conducted a survey of material recovery facilities (MRFs) to inventory needlestick incidences and the surrounding circumstances. The survey was conducted online, with follow-up email and phone calls to clarify reported information. In total, 35 recycling facilities provided information through the survey tool: 28 MRFs and 7 combined MRF/transfer stations. No responses were received from mixed waste MRFs (i.e. "dirty MRFs"). Facilities were primarily located in the United States (91%), representing 12 states and approximately 5% of total U.S. MRFs. The remaining facilities were located in two provinces in Canada. While small, this sample size (35) yields sufficient confidence in results (80% confidence with $\alpha = 0.15$). The sample size did restrict the ability to compare rates within the group (e.g. by facility type, by region), and caution is therefore advised when assuming national results are presentative of individual facilities or locales.

Respondents included small facilities with limited operating hours and large 20+ hour/day highly-automated MRFs. Nearly all facilities (97%) reported accepting both residential and commercial recycling, with an average composition of 70% residential material. Over half (57%) accepted non-hazardous recyclable material from health care sources (e.g. doctor's offices), whereas 31% of facilities did not accept material from health care sources. The remaining 11% of respondents were unsure.

Results suggest that needles are routinely observed at MSW MRFs. Ninety-seven percent of MRFs reported seeing needles or syringes at least one time per year. Over half of recycling facilities (53%) reported observing needles frequently (i.e., daily or a few times a week) (Figure 3).

Figure 3. Reported Frequency of Needle Observations at MRFs

Responses to Q 19 "How often are needles and/or syringes observed in the incoming recyclables stream?"



Similar rates were reported by MRFs that do and do not accept health care facility wastes, with 20% of each group observing needles daily and 30% observing needles a few times per week (Table 4). This suggests that improper sharps management at healthcare facilities is not the primary cause of needles at MSW recycling facilities.

Table 4. Frequency of Needle Observance for MRFs with and without Health Care Waste (HCW)[a]

Reported Frequency of Needles Observed at MRF	With HCW		Without HCW	
	% of Facilities	Cumulative	% of Facilities	Cumulative
Daily	20%	20%	20%	20%
A few times a week	30%	50%	30%	50%
A few times a month	35%	85%	10%	60%
A few times a year	10%	95%	40%	100%
Never or less than once per year	5%	100%	0%	100%

[a]Facilities that were unsure if HCW was accepted were excluded from the analysis.

Depending on facility design, needles and other healthcare sharps could end up in various lines in the MRF. Facilities reported needles in the glass, plastics, fiber, and fines/residue lines (Table 5). Most facilities (72%) reported that observed needles are pulled off the line as contamination.

Table 5. Location Where Needles are Reported

Responses to Q 20 "Where in the recycling line(s) do the needles end up? (Check all that apply)"

Location or Line Type	% of Facilities[a]
Plastics	52%
Fines/Residue	48%
Glass	33%
Presort	10%
Fiber	10%

[a]Total is greater than 100%, as some facilities reported needles end up in multiple lines

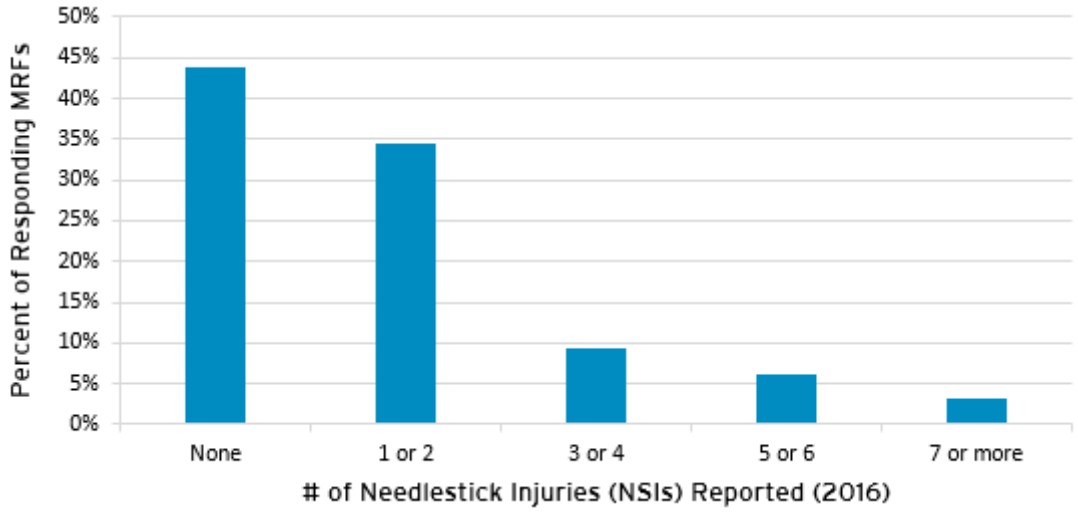
Quantity of Needlesticks and Related Events.

Given the frequency with which needles are observed on sort lines, and the common practice of removing needles as contamination, it is unsurprising that 97% of MRFs indicated NSIs were a "very important" or "important" concern relative to other incidences at their facility. In the U.S., the primary resource for workplace injury and fatality data is the U.S. Department of Labor Bureau of Labor Statistics (BLS), the federal agency tasked with tracking nationwide labor statistics such as: employment, inflation, productivity, and workplace injuries. The BLS estimates rates for various injuries related to needlesticks (codes 7511XX, 61XXXX, and 5541XX) and punctures (code 037XXX), however these values are withheld for waste management (NAICS 562) and MRFs (NAICS 56292) as values do not meet publication guidelines (BLS, 2018; BLS, 2017). As a result, BLS estimates of NSI risk for recycling workers are not disseminated or otherwise made available to the industry.

To quantify MRF NSI rates, recycling facilities were asked to voluntarily report the number of needlesticks and related events that occurred during 2016. Approximately 91% of survey respondents provided needlestick-related information, representing 32 MRFs and roughly 1670 MRF employees.

A total of 103 needle-related events were reported: 46 where a needle stuck to PPE without incident and 57 where needlestick injuries occurred. Needle-related events (i.e. those with and without injury) were reported by two-thirds of facilities for 2016. Needlestick injuries were reported at 56% of facilities, where most commonly either 1 or 2 injuries had occurred during the year (Figure 4). All reported injuries occurred to the hands. Picking line workers accounted for nearly all NSIs (98%), with the remainder being maintenance workers (2%).

Figure 4. Number of Needlestick Injuries at MRFs Annually



Calculation of MRF Needlestick Injury (NSI) Rate. The MRF needlestick injury (NSI) rate was calculated based on respondent data for number of NSIs, number of employees, length of shift and operating hours. Rates were calculated using the standard BLS injury calculation of incidences per 100 full-time equivalent (FTE) employees, as:

$$\text{Incidence Rate} = (N/EH) \times L \qquad \text{[Eqn. 1]}$$

where:

N = number of injuries and illnesses

EH = total hours worked by all employees during the calendar year

L = 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year) = 200,000

(BLS, 2017)

For 2016, the overall needlestick injury rate for MRFs was 2.7 per 100 FTE (Table 6). The rate for U.S MRFs was 2.7 per 100 FTE. The NSI rate varied greatly by job function, with nearly all (98%) reported needlesticks affecting picking line workers. Considering picking line workers exclusively, the needlestick injury rate is 3.9 per 100 FTE. The U.S. rate was calculated to be 4.2 per 100 FTE. Of the 57 NSIs reported in the survey, 4 NSIs (7%) resulted in day(s) away from work, or a U.S. rate for NSIs with day(s) away of 0.18 per 10,000 FTE.

Table 6. Calculated MRF Needlestick Injury (NSI) Rates

	Overall NSI Rate[a]	Facility NSI Rate Range[b]
MRF- overall	2.7	N/A
U.S. only	*2.7*	*0 - 20.0*
MRF- picking line	3.9	N/A
U.S. only	*4.2*	*0 - 23.5*

[a]Rate per 100 FTE, calculated using Equation 1.
[b]Range of calculated facility NSI rates

It is worth noting that these estimates are based on a survey of facility owners/operators, and not a survey of individual employees. It is possible that MRF NSI rates are higher than estimated since a portion of NSIs are go unreported. A direct survey of waste collection workers found that only 10% of occupational NSIs were reported (Turnberg and Frost, 1990).

Nationwide Estimate of Injuries and Cost. To better understand the potential nationwide impact of needles and other medical sharps at MRFs, an estimate of nationwide statistics and their associated costs was derived. Although the most straight-forward method would be to extrapolate based on the FTE of U.S. MRFs, this figure could not be identified. Therefore, estimates were derived based on alternate metrics for the size of the MRF industry (Table 7). Results suggest that between 781 and 1,484 NSIs may occur at these facilities each year.

Table 7. Size of U.S. MRF Industry

Size Indicator	Size	Year	Source
Number of Facilities, MSW MRFs	799	2013	EREF, 2016
Annual Tonnage Processed, MSW MRFs	53,766,697	2013	EREF, 2016b
Employment, all MRFs (NAICS 56292)	21,795	2015	USCB, 2018

Direct costs were estimated based on available data, and may include:

- Initial testing and treatment of the injury,
- Post-exposure prophylaxis (PEP) to prevent virus transmission, and
- Follow-up monitoring and testing for virus transmission and PEP side-effects.

A review of available data suggests that median and average direct costs are $173 to $512 per injury, respectively (Mannocci et al., 2016). This suggests that each year, NSIs could cost MRFs and their employees

between $135,113 and $759,808 in direct costs. The highest reported direct costs per NSI was $1,516, or an estimated high-end direct costs of $2.25 million in annually.

This cost estimate does not include additional indirect costs associated with incoming needles, which may be significant. Examples of indirect costs of NSIs include:

- Treatment and management of infections contracted from needlesticks;
- Employee turnover and lost productivity due to NSIs or fear of NSIs (Green and Griffiths, 2013);
- Maintenance, repair, and/or replacement of equipment due to damage from needles; and
- Revenue loss associated with stopping sort lines due to injury, needle sighting, or equipment damage.

Comparison to Other Injury Rates in the United States.

BLS (2017) reports the overall workplace injury and illness rate in the U.S. was 3.2 recordable cases per 100 FTE for 2016 (Table 8). The highest reported injury and illness rates for any industry were in nursing and residential care facilities (13.7 per 100 FTE), veterinary services (12.3 per 100 FTE) and police protection (10.2 per 100 FTE). Waste management and remediation reported an injury and illness rate of 4.0 per 100 FTE. Within waste management and remediation, materials recovery facilities had the highest total injury rate (6.0 per 100 FTE), followed by solid waste collection (5.2 per 100 FTE) and solid waste landfills (4.9 per 100 FTE).

Table 8. Selected BLS Reported Illness and Injury Rates for 2016[a]

Industry[b]	NAICS code[c]	Rate of recordable injuries/illness[d]
All industries including private, state and local government[e]	N/A	3.2
Nursing and residential care facilities	623	13.7
Veterinary services	54194	12.3
Police protection	92212	10.2
Waste management and remediation services	562	4.0
Materials recovery facilities	*56292*	*6.0*
Solid waste collection	*562111*	*5.2*
Solid waste landfill	*562212*	*4.9*
Solid waste combustors and incinerators	*562213*	*1.0*

[a]Excerpted from: BLS, 2017
[b]Displayed industry may include additional/multiple subsectors
[c]NAICS = North American Industry Classification System
[d]Per 100 FTE, calculated using Equation 1
[e]Excludes farms with fewer than 11 employees

The BLS estimate for total MRF illnesses and injuries (6.0 per 100 FTE) suggests that NSIs comprise 45% of total reportable incidences at MRFs.

Concern around needlestick injuries (NSIs) often centers on the following occupation groups:

- Healthcare workers who use needles and other sharps during patient care
- Police who may encounter needles during searches and other enforcement activities
- Emergency responders who may encounter needles when responding to dreg-related calls
- Veterinarians and farmers who use needles for animal care and livestock husbandry
- Solid waste workers who may come in contact during collection, processing, and disposal activities .

Limited data exists on occupation-specific needlestick injury rates. Rates are withheld in BLS reporting for standard occupation classification (SOC) codes, as values do not meet publication guidelines (BLS, 2018; BLS, 2017). Some estimates of needlestick injuries are available in the scientific literature, though many focus on a limited population of interest (e.g. specific city or state) (Table 9). The highest estimated NSI rate was for hospital workers, with an estimate of 24.9 per 100 workers (International Safety Center, 2016). Nearly 400,000 NSIs are estimated for hospital health care workers annually (Panlilio et al., 2004).

Table 9. Prevalence of Needlestick Injuries for Various Occupations

Industry or Occupation	Number of NSIs (annually)	NSI Rate[a]	Year
U.S. MRF Workers	781 to 1,484	2.7	2016
U.S. MRF Picking Line Workers	-	4.2	2016
Waste Collection Workers (NYC)	31	1.04	2001[e]
Sanitation Workers (NYC)	50 to 100	-	1975[f]
Waste Collection Workers (WA)	-	5 to 10[b]	1989[g]
Healthcare Waste Handlers (UK)		6.89	Early 2000s[h]
Hospital Workers, all	-	24.9[c]	2016[i]
Hospital Health Care Workers	384,325	-	1998[j]
Registered Nurses	-	15.6[b]	2002[k]
Police Officers (San Diego)	-	29.7%[d]	2000[l]
Police Officers (Denver)	4	0.3[b]	1990-91[m]

[a]Per 100 Full Time Equivalent workers, unless otherwise noted
[b]Per 100 workers
[c]Per 100 patients (average daily census). Adjusted to not include other sharps (e.g. scalpels).
[d]Percent of officers reporting 1 or more NSIs during their career
[e]Lawitts, 2002
[f]Cimino, 1975
[g]Turnberg and Frost, 1990
[h]Blenkharn and Odd, 2008
[i]International Safety Center, 2016
[j]Panlilio et al., 2004
[k]Trinkoff et al., 2007
[l]Lorentz et al., 2000
[m]Hoffman et al., 1994

Within waste management occupations, NSI rates ranged from 1.04 per 100 FTE for collection workers in NYC (Lawitts, 2002) to up to 10 per 100 employees for collection workers in the state of Washington (Turnberg and Frost, 1990). Blenkharn and Odd (2008) estimated the NSI for medical waste handlers in the United Kingdom to be 6.89 per 100 FTE, or roughly 2.5 times the NSI rate of MSW MRF workers (Table 9).

Although data are not available through BLS for total NSIs, data are available for those resulting in day(s) away for private, state, and local government industries (BLS, 2018). In 2016, there were 1,690 NSIs involving day(s) away from work, or a rate of 0.2 per 10,000 FTE. Needlestick-specific data are not published for all occupations, however estimates are available for some broad occupation groups (Table 10).

Table 10. Needlestick Injuries (NSIs) with Day(s) Away by Occupation and Ownership[a]

Occupation Group, by ownership[a]	Rate per 10,000 FTE	Number w/ day(s) away	% of Total w/ day(s) away
Healthcare practitioners and technical, all	0.9	570	34%
Healthcare, private	*0.6*	*360*	*21%*
Healthcare, state and local combined	*2.8*	*220*	*13%*
Service, all	0.5	960	57%
Service, private	*0.3*	*440*	*26%*
Service, state and local combined	*1.7*	*520*	*31%*
Farming, fishing, and forestry, all	0.5	50	3%
TOTAL	**0.2**	**1,690**	

[a]Based on BLS (2018), with injury source code 7511XX (Needles, syringes). Includes days away with or without job transfer for restriction.
[b]Reported based on the U.S. Office of Management and Budget (OMB) Standard Occupational Classification Manual (BLS, 2010)

Occupation groups with highest rates of NSI with days away are healthcare practitioners (e.g. nurses, veterinarians), service (e.g. protective service, grounds cleaning and maintenance, food preparation), and farming, fishing, and forestry. Over half (57%) of these occurred to Service workers. Roughly one-third (34%) occurred to healthcare practitioners. Reported incidences rates in these groups ranged from 0.3 per 10,000 FTE (Service, private ownership) to 2.8 per 10,000 FTE (Healthcare practitioners and technical, state and local government). The rate for U.S. MRFs, estimated based on data reported to EREF, is 0.18 per 10,000 FTE; roughly equal to the overall U.S. rate (0.2 per 10,000 FTE).

STRATEGIES FOR ADDRESSING NEEDLES IN MSW STREAMS

Many strategies have been used to reduce the potential hazard of medical sharps in the waste stream. As part of this study, activities were identified across the standard Hierarchy of Controls (NIOSH, 2018). The Hierarchy includes, from most to least preferred:

1) Elimination of Hazard
2) Substitution or Replacement of Hazards
3) Engineering Controls
4) Administrative or Work Practice Controls
5) Personal Protective Equipment (PPE)

Sharps Diversion from the MSW Stream (Elimination of Hazard).

Diversion of sharps can occur through a variety of program types. The primary types of household needle diversion programs are:

- community drop-off sites
- mail-back programs,
- syringe exchange programs, and
- residential special waste pickup services.

These program options seek to divert needles from the household waste stream, eliminating the hazard to MSW facility workers at the point of collection. In addition to diverting needles from the MSW stream, diversion programs have the added benefit of aggregating household sharps for safe treatment as medical waste.

Community Drop-Off Sites.

Community drop-off sites provide residents a collection point for proper sharps disposal. Sites can include: established one-way drop boxes placed within the community (e.g. in restrooms, at fire stations, pharmacies); designated receptacles at local waste centers or transfer stations; and periodic or one-time collection events similar to other hazardous waste, e-waste, or shredding events. Typically, these collection points can be accessed anonymously by the public for needle or sharps drop off, encouraging the safe disposal of sharps originating from both prescribed and illicit drug use (Figure 5).

Figure 5. Needlestick Drop-off Sites in California and Washington[a]

[a]Left: Airport drop-off box; Right: Seattle drop-off box (King County, 2016)

Based on a nationwide database of drop-off centers and events, there were 3,715 community drop-off sites across the U.S. in 2017 (NeedyMeds, 2018). Drop-off sites are available in 43 states: no sites were identified in Alabama, Connecticut, Hawaii, Montana, North Dakota, South Carolina, and Vermont (NeedyMeds, 2018). Of those states with drop-off available, sites were notably more prevalent in states with CHN co-disposal bans (i.e., CA, MA, OR, and WI). Among these states, the average estimated service level was 1 site per 34,267 residents. For states without bans, the average estimated service level was 1 site per 943,261 residents. This means drop-off availability was, on average, 27.5 times higher per-capita in states with CHN co-disposal bans.

Mail-Back Programs. Mail-back programs provide patients with the ability to properly dispose of sharps by mailing approved sharps containers to a central location for processing. Mail-back programs provide a convenient option for residents, often in rural areas, who lack easy access to other diversion strategies. However, the cost to participate can be prohibitive for some (Lanio, 2007). When enrolling in a mail-back program, residents are typically responsible for paying a subscription cost, the cost of approved containers, and/or postage fees.

Mail-back programs are generally implemented by either:

- injectable pharmaceutical and medical supply companies (NeedyMeds, 2018), or
- private MSW management companies (e.g., Waste Management MedWaste Tracker™, Republic Services Mail-Back System).

It is worth noting that private medical waste management companies (e.g. Stericycle) generally do not service individual residential generators. Rather, they serve large Regulated Medical Waste (RMW) generators such as hospitals and, in many cases, the community drop-off sites.

Syringe Exchange Programs. Syringe exchange programs (SEPs) provide free access to sterile needles as well safe disposal of used needles. When program participants return used needles, they receive sterile needles in exchange, typically under a one-for-one, one-for-two, or unlimited arrangement. In some cases, participants can also receive free sharps containers. SEPs generally target people who inject drugs (PWID), seeking to prevent the transmission of disease associated with sharing needles (e.g., HIV) as well as improper disposal of loose needles in public spaces (e.g., in parks, dumpsters). Studies show that SEPs significantly reduce the prevalence of improperly discarded syringes, thereby reducing needlestick risk not only for waste management personnel handling waste and recycling from public spaces, but also police and emergency personnel who routinely come in contact with PWID (Quinn et al., 2014; Tookes et al., 2012).

An estimated 205 SEPs exist across the U.S., in 42 states plus Washington D.C. and Puerto Rico (NASEN, 2014). SEPs reported collecting 45.9 million syringes in 2014 for a total of 390 million syringes collected from 1998 through 2014 (Des Jarlais et al,, 2014). The majority of SEPs (71%) use private sanitation contracts for final disposal, followed by self-haul directly to facilities, transferring to other exchanges, or disposal through private doctors offices or clinics (Des Jarlais et al, 2014).

Residential Special Waste Pickup. Residents in some areas have access to special waste pickup services either with regularly scheduled service or as-needed scheduling. These services are typically fee-based, and typically available through the city or county. While believed to be less common than the other diversion program types, the number of special waste programs available in the U.S. is unknown (Table 11).

Table 11. Summary of Needle Disposal Programs

Program Type	Target Participants		Fees Typically Paid Directly by User?	# Programs Identified in the U.S.[a]
	Home Health	PWID		
Drop-Off	✓	✓		3,715
Mail Back	✓		✓	22
Syringe Exchange	✓	✓		205
Special Waste Pick-up	✓		✓	-

[a]Drop-off and Mail Back counts generated from NeedyMeds databases (2018, 2018b), Syringe Exchange estimate from NASEN (2014)

Needle Design and Destruction (Engineering Controls). Two types of engineering controls exist for reducing the risk of needlestick injuries: redesigned needles (i.e. safety needles) and needle destruction devices. These controls seek to reduce or neutralize the sharps, leading to safer disposal. In addition, the devices prevent the re-use of needles, which has the added benefit of reducing infection associated with sharing needles. While these devices reduce the risk of NSIs, the risk is not eliminated completely. Some NSIs can still occur when activating safety features (Figure 1).

Safety Needles. Two types of safety needs were identified.

- **Retractable or sheathed needles** feature a sheath or other enclosure outside of the needle to prevent the potential danger of needlesticks due to re-capping or improperly handling used needles.
- **Self-blunting needles** contain a sleeve within the barrel of the needle. The blunt sleeve remains extended after use, inhibiting the needle from puncturing skin after the injection.

In the U.S., the adoption of safety needles has reduced the rate of NSIs for nurses by 34% (Jagger, 2008). The use of redesigned or safety needles has been mandated in some health care facilities, including California in the U.S. and Manitoba and Saskatchewan in Canada (CAUT, 2007).

Destruction Devices. These devices seek to neutralize the sharp through physical destruction.

- **Disintegration devices** destroy needles by means of electric current or heat. Due to their small size, the devices are often battery operated and portable. This makes them useful for reducing improper needle disposal when away from the home.
- **Needle clipping devices** disable the needle by removing the sharp tip of the needle from the body or syringe. These devices often store the sharp section of the needle for proper disposal and allow for the body or syringe to be disposed without posing a needlestick risk.

Practices Implemented at MRFs to Reduce Hazard (Administrative/Work Practice Controls).

As part of the survey of U.S. and Canadian MRFs, facilities shared policies that had been implemented to address the risk of needlestick injuries (NSIs). Nearly three-quarters (74%) of responding facilities reported implementing changes due of the concern for NSIs. Reported changes focused on five areas:

1) Establishment of a written protocol for needles seen on the line, such as "Stop, Call, Wait"
2) Increase in staff safety training and education
3) Change in facility operations (e.g. addition of pre-sort inspections) or equipment (e.g. bag breaker) to reduce hazard
4) Reinforce reporting procedures of needles and needlestick injuries to ensure risk and progress is tracked
5) Education and engagement with residents, community groups, and businesses

Establishing written protocols was the most commonly reported administrative or work practice change in response to needlesticks (29% of facilities), followed by staff training (25%), community engagement (21%), operational changes (18%), and reinforced reporting (11%). Examples of each are shown in Figure 6, below.

Figure 6. Examples of MRF Work Practice Controls[1]

[1]*Note: color corresponds to category above*

Use of Personal Protective Equipment (PPE) at MRFs. PPE is the least preferred, though still vital, method of hazard reduction. As part of the survey effort, facilities reported the types of PPE commonly worn by their employees. Response rates for the various types of PPE are shown in Table 12. The most commonly reported PPE types were gloves (100% of facilities), protective eyewear (86%), high-visibility outerwear (77%), and boots (74%).

Table 12. Reported Use of Personal Protective Equipment (PPE) Types
Responses to Q 16 "What kind(s) of personal protective equipment (PPE) are most commonly worn by employees at the facility? (Check all that apply)"

Personal Protective Equipment (PPE) Type	Percent of MRFs Reporting (%)
Gloves	100%
Gloves- cloth/leather	*56%*
Gloves- plastic/nitrile/latex	*40%*
Gloves- puncture proof/resistant	*63%*
Boots	74%
Boots- leather/rubber	*40%*
Boots- steel toe	*49%*
Hard Hats	51%
Protective Eyewear	86%
Ear Protection	71%
Protective Body Clothing	26%
High-visibility outerwear (shirt/vest)	77%
Other[a]	20%

[a]Other includes: dust masks, filters, and respirators; chemical-resistant gloves; arm sleeves and supports; chaps; and fatigue mats.

Although 100% of MRFs reported gloves were worn as part of employee PPE, most reported that multiple types of gloves are available for use. Puncture proof/resistant gloves were the most common type of glove reported (63%), however only one-quarter of facilities indicated puncture proof/resistant gloves were worn exclusively.

In response to the risk of NSIs, 25% of facilities reported changes in PPE and enforcement. Over half of those indicated PPE as the sole change made in response to NSIs. While offering sufficient PPE is an element of worker safety and needlestick prevention, NSI rates were not significantly different for in facilities with and without puncture-resistant gloves. Therefore, comprehensive safety plans and focus on additional in-house strategies (e.g. training) and community engagement (e.g. working with pharmacies to increase diversion) are likely necessary to further reduce the risk of NSI at MRFs.

SUMMARY

Needlestick injuries are an important concern within the waste industry. Three-quarters of material recovery facility (MRF) owners and operators reported needlestick injuries are "very important" relative to other risks. Key insights from this study on disposal guidance, injury rates, and programs are summarized below:

State Disposal Guidance.

Confusion or lack of education regarding household sharps disposal is one factor in needlestick injury risk.

1) Four states (CA, MA, OR, and WI), as well as individual cities and counties in other states, ban the disposal of household needles in residential wastes. In the remaining 46 states and Washington D.C., residents can dispose of containerized household needles (CHN) in the residential waste stream.

2) Guidance varies greatly, such as by the type of containers allowed, container labelling requirements, and if disinfection or other pre-treatment is required before placing CHN in their curbside bin.

3) Despite guidance and bans, 95% of needles are discarded unprotected in the MSW stream (UltiCare, 2018)

Needles and Needlestick Injuries (NSIs) at Recycling Facilities.

Based on a survey of U.S. and Canadian material recovery facilities (MRFs):

1) Needles are routinely seen at MRFs, and typically end up in the plastics, glass, or fines/residue lines.

2) Over half (53%) of surveyed facilities had one or more needlestick injuries (NSIs) in 2016.

3) NSIs in MRFs occur at an estimated rate of 2.7 per 100 full-time equivalent (FTE) employees
    - Picking line workers experience NSIs at a higher rate, approximately 3.9 per 100 FTE

4) Based on these results, as many as 1,484 NSIs may occur each year at U.S. MRFs, and could cost the industry and employees up to $2.25M in direct costs for treatment, prophylaxis, and monitoring.

5) When compared to the total U.S. MRF incidence rate, NSIs comprise:
    - 45% of all injury and illness incidences
    - 0.1% of injury and illness incidences that required day(s) away from work

Programs and Practices to Address Needles in the Waste Stream.

Multiple programs and practices were identified to address the risk posed by needles in the waste stream.

1) Needle collection programs include: drop-off (3,715 programs in 43 states), mail-back (22 programs), syringe exchange (205 programs in 24 states), and special waste pickup programs.

2) MRFs have taken a variety of actions in response to needles and NSI risk, including:
    - Establishing written protocols for when needles are seen on the line,
    - Increasing staff training and education,
    - Working within the community to establish needle collection programs,
    - Changing facility operations or equipment (e.g., adding pre-sort inspection, bag-breakers), and
    - Modifying personal protective equipment (PPE) requirements.

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