American Journal of Infection Control 45 (2017) 377-83

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Risk of sharps injuries among home care aides: Results of the Safe Home Care survey

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Key Words:
Needlesticks
Home health care

Objectives: Home care (HC) aides constitute an essential, rapidly growing workforce. Technology advances are enabling complex medical care at home, including procedures requiring the percutaneous use of sharp medical devices, also known as sharps. Objectives were to quantify risks of sharps injuries (SI) in a large HC aide population, compare risks between major occupational groups, and evaluate SI risk factors.
Methods: A questionnaire survey was administered to aides hired by HC agencies and directly by clients. One thousand one hundred seventy-eight aides completed questions about SI and potential risk factors occurring in the 12 months before the survey. SI rates were calculated and Poisson regression models identified risk factors.
Results: Aides had a 2% annual risk of experiencing at least 1 SI (95% confidence interval [CI], 1.1-2.6). Client-hired aides, men, and immigrants had a higher risk than their counterparts. Risk factors among all HC aides included helping a client use a sharp device (rate ratio [RR], 5.62; 95% CI, 2.75-11.50), observing used sharps lying around the home (RR, 2.68; 95% CI, 1.27-5.67), and caring for physically aggressive clients (RR, 2.82; 95% CI, 1.36-5.85).
Conclusions: HC aides experience serious risks of SI. Preventive interventions are needed, including safety training for clients and their families, as well as aides.

In North America, home care (HC) is among the fastest growing industries and HC aide is among the fastest growing occupations.[1,2] There are nearly 3 million home health aides[3] and personal care aides[4] currently employed in the United States. Those in need of HC are predominantly elders, aged 65 years or older, followed by people of all ages with illness or cognitive or physical disabilities.[5] The high demand for HC is driven by several factors: a rapidly aging population worldwide and the desire of most people to receive care in their homes.[6] Additionally, technology advances are increasingly enabling complex medical care to be provided at home, including dialysis, chemotherapy, and intravenous (IV) administration of antibiotics and other home infusion therapies, vitamin injections, and diabetes management.[5] Many of these procedures require the percutaneous use of sharp medical devices such as lancets, syringes, and other needles, collectively called sharps. HC personnel can experience serious blood infections, including HIV and hepatitis B (for the unvaccinated) and C, when they are stuck or cut by a sharp previously used to perform a procedure on a patient.[7,8] The risks of sharps injuries (SI) have been evaluated in hospitals and other institutional settings,[9] but only a few studies have focused on HC.[10-16] Specific objectives of this study were to quantify the SI risk in a large population of HC aides, compare risks between 2 major aide occupational groups, and evaluate SI risk factors so that public health interventions can be developed.

BACKGROUND

There are several occupational titles for aides working in HC, such as personal care attendant and home health aide; in this study, "HC

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Funded by the National Institute for Occupational Safety and Health (grant No. R01 OH008229), which had no role in the study design, data gathering, analysis, interpretation of the data, or writing of the manuscript. The corresponding author had full access to all the data and final responsibility for the decision to submit for publication.
Conflicts of interest: None to report.

http://dx.doi.org/10.1016/j.ajic.2016.11.018

aide" or "aide" refers to all aide occupations. Although there are differences in job duties among aide occupational titles most aides assist someone in their home with mobility, such as helping someone move from bed to wheelchair, and with activities of daily living, such as physical exercising, bathing, dressing, toileting, skin care, food preparation, and house cleaning.[17] HC aides in Massachusetts are not licensed to perform medical procedures, including the administration of medications involving sharps. Unlike aides in HC institutional settings, HC aides usually work alone.

HC recipients are called patients, clients, or consumers, depending on how the aide who visits them is hired. Here we use "client" to refer to all types of HC recipients. HC aides mainly are hired in 2 ways: a private business called an agency hires the aide, an agency-hired aide, assigns her or him to the client, and supervises the work; or the client or client's family hires and supervises the aide directly, a client-hired aide. Both groups of aides are paid mostly through health insurance or publicly funded social service programs. Aides hired entirely with private funds were beyond the scope of this study.

Agency-hired aides are usually supervised by a nurse who develops a formal care plan for the client before an aide's first home visit. The care plan may be more informal for client-hired aides. In Massachusetts, client-hired aides are organized by a labor union; agency-hired aides typically do not belong to a union. The amount of training for HC aides varies by state, with 75 hours of training required for agency-hired aides in Massachusetts.[18] Recently, promising initiatives have developed health and safety training for HC aides with a focus on those hired by clients.[19-21] However, client-hired aides typically have less training.[22] Some HC aides obtain professional certifications such as certified home health aide, certified nursing assistant, certified homemaker, and certified hospice aide.

METHODS

Study design, population recruitment, and survey administration

A questionnaire survey was conducted in partnership with 7 HC aide agencies in eastern Massachusetts comprising 16 site locations to recruit agency-hired aides and 1 HC aide labor union to recruit client-hired aides during September 2012-April 2013. Agencies were identified via the main HC aide industry association and were representative of both the HC aide and client populations in that they were from a variety of locations (urban, suburban, or rural) and served a range of racial and ethnic populations. The labor union represented HC aides who were directly hired by clients receiving public assistance from social services in Massachusetts.[23] The questionnaire was designed to be self-administered and was distributed to agency-hired aides at in-person training sessions organized by the agencies and to client-hired aides via the postal mail in collaboration with their union. Details of the questionnaire development and administration are described elsewhere.[24] The work presented here is part of a larger initiative called the Safe Home Care Study, which evaluated a broad range of working conditions among a population of 1,249 HC aides aged at least 18 years and employed for at least 1 year in HC.[24] The population in this article is a subset comprising 1,178 HC aides who responded to the questions on SI. The survey methods described here were informed by a presurvey qualitative methods study that used focus groups with HC aides and in-depth interviews with industry and labor representatives to characterize the nature of HC work and to identify feasible population recruitment methods for this difficult-to-access population.[25] Postsurvey focus groups and interviews also were conducted to gain insights about the survey results. All methods and materials were approved by the University of Massachusetts Lowell Institutional Review Board.

Questionnaire development

Units of analysis

The questionnaire was designed in 2 parts, each focusing on a different unit of analysis. In part 1, the unit of analysis was the individual HC aide and the questions assessed demographic characteristics, occupational history, safety climate, and health outcomes experienced by the aide in the past 12 months, including the number of SI and experiences of violence. The time period of 12 months was chosen to capture the relatively rare events of SI. One year is a standard occupational time period, including in the only national survey of HC aides.[26]

In part 2 of the survey, the unit of analysis was the HC visit and questions assessed hazards or conditions hypothesized to be risk factors for SI. Hypotheses were developed a priori from the literature[14,27] and from our previous research.[28] Collecting data at the visit level allowed calculation of rates of occurrence of hazards and conditions as a proportion of specific client visits; questions elicited information on hazards and conditions that could be expressed as the percent of all visits. For example, an aide was asked whether she saw sharps lying around the house or if she helped a client use a sharp during a particular visit. Typically an aide performs many visits in a week, and the conditions that can influence an SI may be quite different in each home. Gathering hazard data at the visit level allowed us to evaluate this variability, and to summarize working conditions in a more meaningful way than if we had used a question like: "How often do you dispose of used sharp medical devices (needles, syringes, lancets)?" which would be difficult for the aides to answer given their highly variable experiences. Part 2 began with questions about hazards and conditions during the most recent HC visit. This same set of questions was repeated up to the 5 most recent visits with distinct clients during the past month.

Health outcomes (part 1)

Sharps injuries.

Questions used to evaluate SI were developed in our previous study.[15] The questions ascertained whether a HC aide had been stuck or cut by a previously used sharp medical device, such as a needle or lancet, while working in HC. Aides were asked whether they had ever experienced an SI in their HC work and, if yes, the number of SI events during the past 12 months. The specific question was: "In the past 12 months, how many times have you been stuck or cut by a previously used medical sharp device?"

Violence.

Experiences of verbal and physical violence can have serious health consequences and we hypothesized that they might also be risk factors for SI. The questions on violence ascertained whether, during the past 12 months, the aide had experienced any of the following by a client: physical violence, including aggressive physical contact (eg, pinched, scratched, slapped, or punched), being bitten or spit on, objects or bodily fluids thrown at them, beaten or strangled, sexual assault; or verbal violence, including verbal threat of harm, made to feel bad about oneself, racist language, or racial insults, ethnic insults, religious insults, other personal insults, or being yelled at or spoken to in an angry or humiliating tone. These questions were adapted from the 2007 National Home Health Aide Survey[26] and from our focus groups and in-depth interviews.[25]

Hazards experienced during specific HC visits (part 2)

The questions in part 2 mainly were composed of checklists of hazards and conditions identified in our earlier studies,[15,29] our focus groups and in-depth interviews,[25] the 2007 National Home Health Aide Survey,[26] and other HC literature.[14,27] Specific items related to sharps hazards were: "During this visit, did you help either the client

or anyone else use a sharp medical device, such as a needle, syringe or lancet (for example to check blood sugar levels or inject insulin)?", "During this visit, did you dispose of used sharp medical devices (needles, syringes, lancets)?", and "Did you experience any of the following in the client's home during this visit: Used sharp medical devices (needles, syringes, lancets) lying around?"

Data analyses

Construction of variables

Aides were asked to report the typical number of hours per week worked in their HC jobs. The number of hours was presented in 4 possible categories that were represented by their midpoints in constructing a variable for risk modeling. The categories (and their midpoints) were: <10 hours (n = 5), 10-20 hours (n = 15), 21-40 hours (n = 30), and more than 40 hours (n = 50) per week. We used this to estimate the total annual number of hours worked and expressed this as the number of full-time equivalent (FTE) hours per individual, based on a standard 2,000-hours per year.[30]

Because the outcome data were collected over a 12-month period and risk factor data were drawn from visits in the month before the survey, new variables were created to link an aide to the visits she or he reported and to summarize hazardous exposures and working conditions hypothesized to be risk factors for SI across all her or his visits. These variables identified aides who reported at least 1 visit with a client who was a family member, spoke a common language with the aide, had limited mobility, had diabetes, had dementia, had mental illness or other psychological issues, received home dialysis, or received IV therapy. Similarly constructed variables also represented aides who reported at least 1 visit during which they helped use sharps, disposed of used sharps, did the laundry, changed the bed linens, or took out the trash; and aides who reported at least 1 visit in a home that was cluttered, had too little space to work, or had used sharps lying around.

Statistical analysis

The principal outcome variable was the number of SI reported in the past 12 months. Using reported work hours, we calculated rates of SI per 100 FTE hours. These were analyzed as retrospective cohort data using Poisson regression (SAS version 9.3, SAS Institute Inc, Cary, NC) to yield rate ratios (RR) for independent risk factors. The annual risk of at least 1 SI also was calculated to allow comparison to other studies that used this metric, but annual risk was not used as an outcome in risk factor modeling.

Univariate models first were constructed to evaluate the association between the number of SI reported during the past 12 months and individual risk factors. Variables associated with the outcome from univariate models were used to build multivariate models to evaluate multiple risk factors. Variables were added one at a time to check for confounding and effect modification. Confounding was indicated by a >10% change in the coefficient of a variable already in the model and a P value < .05 for the variable being added. The FTE was used as the offset in the Poisson models; Akaike's Information Criterion (AIC) was used to assess goodness of fit.

RESULTS

Questionnaires including information on SI were completed by 1,178 aides; the percent of agency-hired versus client-hired aides who completed the questionnaire was similar (51% and 49%, respectively). Agency-hired aides completed 634 surveys yielding a response rate of 84%, whereas client-hired aides returned 621 surveys yielding a response rate of 30%. The population of 1,178 aides provided information on hazardous exposures and working conditions for 3,332 distinct client visits (Table 1). The average age was 47 years; most aides were aged 35 years or older (76%). As in the industry as a whole, the aides were predominantly women (87%) and more than one-third were born outside the United States (37%). Similar proportions of aides self-identified as white (40%) and black (38%); 4% self-identified as Asian. Nearly 20% self-identified as Hispanic or Latino ethnicity. The most commonly held job titles were personal care attendant (30%), home health aide (20%), personal care homemaker (20%), and homemaker (16%); two-thirds held HC certifications (64%). Reflecting the high turnover rate in the industry, nearly one-third of all study aides were employed <2 years (30%) with their current employer, whereas half (49%) were employed 2-9 years and <20% were employed 10 or more years.

There was considerable variability in SI rates by aides' social and occupational characteristics (Table 1). In univariate models, the rate of SI was higher in men than women (RR, 3.25; 95% confidence interval [CI], 1.71-5.90), and among aides born outside of the United States versus native-born aides (RR, 2.56; 95% CI, 1.44-4.54). Client-hired aides were more than twice as likely to experience an SI compared with agency-hired aides (RR, 2.23; 95% CI, 1.23-4.06). Hispanic and Latino aides had a higher risk than non-Hispanics and non-Latinos (RR, 1.91; 95% CI, 1.04-3.50).

Of the 1,178 aides, 22 aides reported experiencing a total of 49 SI during the past 12 months. Of these 22 aides, 11 aides reported 1 SI, 5 reported 2 SI, and 6 additional aides reported 3 or more (maximum, 7) SI. Thus the annual risk of experiencing at least 1 SI was 2% (95% CI, 1.1-2.6; n = 22). Among agency-hired aides (n = 606), 12 aides reported 16 SI, whereas 10 client-hired aides reported 33 SI. When expressed as a rate per 100 FTE workers, the rate of SI for all aides was 6.5 SI per 100 FTE hours (95% CI, 4.9-8.6).

Reflecting the high prevalence of diabetes, especially among older adults,[31] more than half of the aides cared for at least 1 client with diabetes during the month before the survey, and these aides were almost twice as likely to experience an SI (RR, 1.94; 95% CI, 1.04-3.60) (Table 2). Caring for clients who receive home medical services involving sharps such as IV therapy or home dialysis was also associated with a higher rate of SI, as were caring for clients with limited mobility or who exhibited verbally or physically aggressive behavior.

Aides reporting at least 1 client visit during which they observed sharps lying around the client's home were approximately 7 times more likely to experience an SI (RR, 6.89; 95% CI, 3.86-12.32) and aides who helped at least 1 client use a sharp medical device were about 8 times more likely to experience an SI (RR, 7.80; 95% CI, 4.37-13.90) (Table 3). Additionally, aides who reported that clients asked them to perform activities that were not part of their care plan or job description were twice as likely to experience an SI (RR, 2.02; 95% CI, 1.07-3.82). Client homes that were crowded with little space for the aide to work also were associated with a modest increase in risk of SI (RR, 1.43; 95% CI, 0.75-2.72). There was some evidence that aides who reported working for employers (either agencies or clients) who believed an aide's safety and health was important appeared to be protected, although the CI was wide (RR, 0.43; 95% CI, 0.17-1.08).

Significant univariate associations were evaluated in multivariable models to investigate confounding. The final model included 5 independent risk factors (Table 4); all of the other covariates were no longer statistically significant predictors once these 5 risk factors were included in the model. The strongest risk factor was having helped a client use a sharp (RR, 5.62; 95% CI, 2.75-11.50). The final model also indicated that there were important risks associated with working in homes where used sharps were lying around (RR, 2.68; 95% CI, 1.27-5.67) and having physically aggressive clients (RR, 2.82; 95% CI, 1.36-5.85). Men were more likely than women to report SI (RR, 3.90; 95% CI, 2.03-7.50) and those born outside the United States reported a higher rate of SI than those born in the United States (RR, 2.90; 95% CI, 1.47-5.70).

Table 1
Demographic characteristics and sharps injury rates among Safe Home Care Survey aides in Massachusetts, 2012-2013*

Characteristic	Number of aides	%	Number of full-time equivalent employees	Number of sharps injuries	Rate/100 full-time equivalent employees	95% Confidence interval	Univariate rate ratio	95% Confidence interval
Age (y)†								
<35	276	23	169.9	6	3.5	1.6-7.9	0.46	0.20-1.09
≥35	880	75	565.3	43	7.6	5.6-10.3		
Gender								
Male	148	13	97.6	16	16.4	10.0-26.8	3.25	1.79-5.90
Female	1029	87	653.5	33	5.1	3.6-7.1		
Race†‡								
White	468	40	292.3	11	3.8	2.1-6.8		
Black	446	38	282.8	17	6.0	3.7-9.7		
Asian	50	4	29.9	1	3.4	0.5-23.8		
Other	42	3	28.4	0				
Hispanic and Latino ethnicity†								
Yes	198	17	135.5	15	11.1	6.7-18.4	1.91	1.04-3.50
No	939	80	585.6	34	5.8	4.2-8.1		
Nativity†								
Born outside the United States	423	36	281.5	30	10.7	7.5-15.2	2.56	1.44-4.54
Born in the United States	737	63	455.6	19	4.2	2.7-6.5		
Occupation (usual)§								
Personal care attendant	515	30	324.6	34	10.5	7.5-14.7		
Home health aide	342	20	248.6	8	3.2	1.6-6.4		
Personal care homemaker	338	20	235	17	7.2	4.5-11.6		
Homemaker	262	16	162.3	16	9.9	6.0-16.1		
Certified nursing assistant	105	6	72.6	7	9.6	4.3-21.4		
Companion	96	6	62.5	6	9.6	4.3-21.4		
Hospice aide	32	2	22.1	0				
Hired by								
Client	572	49	360.6	33	9.2	6.5-12.9	2.23	1.23-4.06
Agency	606	51	390.6	16	4.1	2.5-6.7		
Tenure with current employer (y)†								
<2	352	30	211.4	12	5.7	3.2-10.0		
2-9	575	49	364	32	8.8	6.2-12.4		
≥10	218	19	158.9	5	3.2	1.3-7.6		
Certification¶								
Yes	758	64	501.3	32	6.4	4.5-9.0	0.94	0.52-1.69
Other or no certification	420	36	250	17	6.8	4.2-10.9		

*Includes all Safe Home Care Survey aides who reported on their sharps injury experience in the 12 months prior to the survey.
†Numbers may not sum to 100% due to unreported data.
‡Fifteen percent did not report race.
§Survey question was: What occupation do you do most of the time in home care?
¶Other certification includes cardiopulmonary resuscitation, first aid, and emergency medical technician.

Table 2
Rate of sharps injury among the Safe Home Care Survey aides by client characteristics, Massachusetts, 2012-2013*

Characteristic	Number of aides	Number of full-time equivalent employees	Number of sharps injuries	Rate per 100 full-time equivalent employee	95% Confidence interval	Univariate rate ratio	95% Confidence interval
Diabetes							
Yes†	564	387.0	35	9.0	6.5-12.6	1.94	1.04-3.60
No	509	299.6	14	4.7	2.87-7. 9		
Intravenous therapy							
Yes†	50	34.3	9	26.3	13.7-50.5	4.57	2.20-9.48
No	979	625.8	36	5.8	4.2-8.0		
Home dialysis							
Yes†	44	34.0	9	26.5	13.8-50.9	4.49	2.17-9.30
No	990	627.4	37	5.9	4.3-8.1		
Limited mobility							
Yes†	864	578.9	46	8.0	6.0-10.6	3.60	1.12-11.58
No	252	136.0	3	2.2	0.7-6.8		
Physical aggression						,	
Yes‡	83	57.6	15	26.0	15.7-43.2	6.41	3.41-12.05
No	1,056	664.9	27	4.1	2.8-5.9		
Verbal aggression							
Yes‡	224	144.0	19	13.2	8.4-20.7	3.22	1.75-5.91
No	892	560.8	23	4.1	2.7-6.2		

*Includes all Safe Home Care Survey aides who reported on their sharps injury experience during the 12 months before the survey.
†Aides who reported at least 1 recent visit to a client with this characteristic.
‡Aides who reported experiencing this during a client visit in the last 12 months.

Table 3
Rate of sharps injury among the Safe Home Care Survey aides by work environment and practices, Massachusetts, 2012-2013*

	Number of aides	Number of full-time equivalent employees	Number of sharps injuries	Rate per 100 full-time equivalent employees	95% Confidence interval	Univariate rate ratio	95% Confidence interval
Crowded, little space							
Yes†	223	155.5	13	8.4	4.9-14.4	1.43	0.75-2.72
No	903	566.1	33	5.8	4.1-8.2		
Sharps lying around							
Yes†	77	55.9	18	32.2	20.3-51.1	6.89	3.86-12.32
No	1,045	663.1	31	4.7	3.3-6.7		
Helped use sharp							
Yes†	113	84.0	23	27.4	18.2-41.2	7.80	4.37-13.90
No	1,038	655.0	23	3.5	2.3-5.3		
Client requests tasks not part of job							
Yes‡	477	300.4	26	8.7	5.9-12.7	2.02	1.07-3.82
No	545	350.3	15	4.3	2.6-7.1		
Employer considers my health & safety important							
Yes‡	1,078	691.0	44	6.4	4.7-8.6	0.43	0.17-1.08
No	53	33.8	5	14.8	6.2-35.6		

*Includes all Safe Home Care Survey aides who reported on their sharps injury experience in the 12 months before the survey.
†Aides who reported at least 1 recent visit to a client with this characteristic.
‡Aides who agreed or strongly agreed with this statement.

Table 4
Final model estimating the association between important risk factors and rate of sharps injuries among aides participating in the Safe Home Care Survey (N = 1,073)

Model	Rate ratio	95% Confidence interval	*P* value
Helped at least 1 client use a sharp	5.62	2.75-11.50	< .001
Used sharp(s) lying around during at least 1 client visit	2.68	1.27-5.67	.010
Aide experienced physical aggression in past 12 mo	2.82	1.36-5.85	.006
Male gender	3.90	2.03-7.50	< .001
Nativity (born outside the United States)	2.90	1.47-5.70	.002

DISCUSSION

This is the largest quantitative study of the SI risks among HC aides to date and the findings have important public health implications owing to the rapidly increasing number of HC aides and the need for a healthy, productive workforce to care for the aging population. We calculated a 2% annual SI risk among HC aides corresponding to an annual rate of 6.5 SI/100 FTE. Although the risk may appear low, this is the annual risk among a large and expanding population of home care workers who generally have limited access to health care. An unexpected finding was the frequency with which aides reported helping clients use a sharp medical device (about 10% of aides) (see Table 3) despite the fact that HC aides in Massachusetts are not supposed to perform medical procedures with sharps. When we investigated these findings further in focus groups, aides reported that they are frequently asked by clients to perform tasks, including medical procedures, outside the care plan and their job descriptions, and it is especially difficult for client-hired aides to refuse.

We also found that men and aides born outside the United States had higher SI risks. When participants in the postsurvey focus groups and interviews were asked about these findings, they reported that male and immigrant aides are often assigned the more difficult, sometimes combative, clients.[32] Additionally, men are more frequently assigned to younger clients with physical and mental disabilities, as well as to elderly clients with limited mobility. Consistent with this observation, aides who reported having clients with limited mobility did have a higher risk of SI (RR, 3.60; 95% CI, 1.12-11.58). The limited mobility variable was not included in the final model because it was correlated with aides of male gender and those born outside the United States and when the latter 2 variables were included in the model, limited mobility was no longer significant. Further study is needed to understand differences in SI risk among aides from different demographic groups.

This study found that medical treatments involving sharps, such as IV therapy and home dialysis, were risk factors for SI, although aides may not directly administer the treatment. Some client characteristics were also SI risk factors, including diabetes, limited mobility, or aggressive physical or verbal behavior.

Previously, we characterized the use of sharps in HC and found important differences from hospital practices.[28] In the home, sharps without engineered safety features are frequently used[15] and they are frequently reused mainly for economic reasons. Additionally, sharps in homes are often disposed of improperly and there may be other household members who use and/or share sharps.[32]

Limitations

It is possible that aides did not accurately remember their experiences with SI over the 12-month recall period. Because SIs are not common, a shorter recall period would have resulted in smaller numbers of events and therefore less statistical power. Repeated surveys every month or so might have resulted in better recall but would have been much more expensive and intrusive for the aides. Annual surveys of injuries are common in occupational health studies and the only published US national HC aide survey also used a 12-month recall period.[26] However, we learned from focus groups that aides experience SI as traumatic events that they are not likely to forget. Recall of injuries can decrease with time and if this was the case in our study, then the true frequency of SI would have been higher.[33]

There were different response rates for the 2 categories of aides: 84% for agency-hired aides and 30% for client-hired aides. This difference was expected and was probably attributable to the different survey administration methods; agency-hired aides were primarily contacted in-person at mandatory agency in-service training sessions, whereas the only way to reach client-hired aides was by postal mail with the collaboration of their union. It is possible that the lower response rate for client-hired aides introduced some bias. We investigated this possibility by adding a variable for agency-hired versus client-hired aide (51% vs 49% of the study population, respectively) to the model in Table 4. The rate ratio associating risk of SI with being client-hired versus agency-hired was 1.36 with a wide CI (95% CI, 0.65-2.88) indicating little evidence of an important difference in reporting rate between these 2 groups. Furthermore,

the relative risks associated with the other variables in the model were not substantially changed either in point or interval estimates (data not shown). These findings suggest that there was not likely to have been important selection bias due to the different recruitment methods for the 2 aide groups.

Another limitation is that there may have been some misclassification of exposure as a result of the need to create variables from the visit-level section of the questionnaire to link the aides to their visits. For example, we cannot pinpoint the exact visit in which an SI occurred because the SI outcomes and the visit hazardous exposures were assessed using different time periods: 12 months for the relatively rare and serious events like SI, and 1 month for the more routine characteristics of a visit that provided most of the risk factor data, such as the clients' health conditions and the home environment characteristics. This could result in some random misclassification of the exposures, which could weaken the ability to find an association between SI and risk factors.

Strengths

A major strength of this study was the partnership with HC agencies and a union to develop effective methods to reach a large population of aides who are otherwise difficult to access because they are geographically dispersed, work alone on irregular work shifts, and have limited time outside of work because they often care for their own family members. To our knowledge, this is the only study that has been able to quantify the occurrence of SI risk factors on a per-visit basis, the main unit for care delivery and for cost reimbursement from insurance or social services programs. The detailed information gathered on the aides' most recent visits enabled us to estimate risks of working conditions that are highly variable from client to client throughout the work day. Additionally, this study provides data for client-hired as well as for agency-hired aides. Quantitative estimates of SI, and indeed of most occupational safety and health hazards, are especially lacking among client-hired aides because they work alone in the home of a single employer. Work isolation, along with low social advantages overall, contribute to a general social invisibility for HC aides and may lead to the misperception that they have few occupational safety and health concerns. This study showed that aides of all types experience SI risks and that client-hired aides are even more likely to experience these risks than those hired by agencies.

CONCLUSIONS

Although using sharp medical devices is not supposed to be part of the job of HC aides, they are nonetheless injured by used sharps. Both client-hired and agency-hired aides experience SI risk. Notably, HC aides were asked by their clients to perform activities that are outside their job description, including helping their clients use sharps. Perhaps not surprisingly, aides who reported helping clients use sharps were more than 5 times as likely to have been stuck or cut with a used sharp medical device than the aides who did not help clients use sharps. Other indicators of sharps use in the home, such as observing sharps lying around, were also important SI risk factors, as was caring for a physically aggressive client. Immigrant HC aides had a higher risk than those who were native born and, although the workforce is predominantly women, men had a higher SI risk. This study provides evidence that can support initiatives to change HC and wider medical practices that include sharps. Safe HC training is needed for physicians and other medical personnel who prescribe HC treatments involving sharps so that they can be aware of the influence on aides. Whenever possible, sharps should be eliminated, including utilizing alternative methods of medication administration. To make this feasible, policy initiatives will be needed to encourage the development of needleless medical devices. When sharps are necessary, devices with engineered safety features should be used[15] and all types of HC aides should receive training on safe handling, disposal, reporting, and prophylaxis in the event of an SI. Physicians, nurses, and other medical professionals should educate HC clients and their families about safe sharps use and disposal at home.

Acknowledgments

The authors thank June M. Fisher, MD, associate clinical professor of medicine emerita, University of California, San Francisco, and director, Training for Development of Innovative Control Technologies Project, Trauma Foundation, for her expert guidance on sharps safety overall and for her emphasis on the re-design of medical technologies to eliminate sharps at their source. Daniel Okyere, ScD, and Chuan Sun, ScD, are gratefully acknowledged for their participation in the Safe Home Care Survey data collection. The authors alto thank the HC agencies, labor union, and HC aides for making this study possible and for providing care that enables so many to live in their homes with dignity.

References

1. Bureau of Labor Statistics. 2015. Occupational Outlook Handbook: Fastest Growing Occupations. Available from: http://www.bls.gov/ooh/fastest-growing.htm. Accessed November 21, 2016.
2. Tencer D. Canada's Fastest-Growing Jobs in the Next Five Years. The Huffington Post Canada; 2015. Available from: http://www.huffingtonpost.ca/2015/06/11/canadas-fastest-growing-jobs_n_7557066.html. Accessed November 21, 2016.
3. Bureau of Labor Statistics. 2015. Occupational Outlook Handbook, 2016-17 edition, Home Health Aides. Available from: http://www.bls.gov/ooh/healthcare/home-health-aides.htm. Accessed November 21, 2016.
4. Bureau of Labor Statistics. 2015. Occupational Outlook Handbook, 2016-17 edition, Personal Care Aides. Available from: http://www.bls.gov/ooh/personal-care-and-service/personal-care-aides.htm. Accessed November 21, 2016.
5. National Research Council. 2011. Health Care Comes Home: The Human Factors. Available from: http://www.nap.edu/catalog/13149/health-care-comes-home-the-human-factors. Accessed November 21, 2016.
6. Seavey D, Marquand A. Caring in America. A Comprehensive Analysis of the Nation's Fastest Growing Jobs: Home Health and Personal Care Aides. Paraprofessional Healthcare Institute; 2011. Available from: http://phinational.org/sites/phinational.org/files/clearinghouse/caringinamerica-20111212.pdf. Accessed November 21, 2016.
7. Centers for Disease Control and Prevention. 2012. Bloodborne Infectious Diseases: HIV/AIDS, Hepatitis B, Hepatitis C. Available from: http://www.cdc.gov/niosh/topics/bbp/. Accessed November 21, 2016.
8. Occupational Safety and Health Administration (OSHA). 1991. Standards Code of Federal Regulations 29 CFR: Bloodborne pathogens 1910.1030. Available from: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051. Accessed November 21, 2016.
9. Perry J, Parker G, Jagger J. EPINet report: 2001 percutaneous injury rates. Adv Expos Prevent 2003;6:32-6.
10. Backinger CL, Koustenis GH. Analysis of needlestick injuries to health care workers providing home care. Am J Infect Control 1994;22:300-6.
11. Gershon RR, Pearson JM, Sherman MF, Samar SM, Canton AN, Stone PW. The prevalence and risk factors for percutaneous injuries in registered nurses in the home health care sector. Am J Infect Control 2009;37:525-33. doi:10.1016/j.ajic.2008.10.022.
12. Haiduven D, Ferrol S. Sharps injuries in the home health care setting: risks for home health care workers. AAOHN J 2004;52:102-8.
13. Leiss JK, Lyden JT, Mathews R, Sitzman KL, Vanderpuije A, Mav D, et al. Blood exposure incidence rates from the North Carolina study of home care and hospice nurses. Am J Ind Med 2009;52:99-104. doi:10.1002/ajim.20646.
14. Lipscomb J, Sokas R, McPhaul K, Scharf B, Barker P, Trinkoff A, et al. Occupational blood exposure among unlicensed home care workers and home care registered nurses: are they protected? Am J Ind Med 2009;52:563-70. doi:10.1002/ajim.20701.
15. Quinn MM, Markkanen PK, Galligan CJ, Kriebel D, Chalupka SM, Kim H, et al. Sharps injuries and other blood and body fluid exposures among home health care nurses and aides. Am J Public Health 2009;99(Suppl 3):S710-7. doi:10.2105/AJPH.2008.150169.
16. Trinkoff AM, Le R, Geiger-Brown J, Lipscomb J. Work schedule, needle use, and needlestick injuries among registered nurses. Infect Control Hosp Epidemiol 2007;28:156-64. doi:10.1086/510785.

17. Home Care Aide Council. 2008. Overview of Massachusetts Home Care Aide Career Ladder. Available from: http://www.mahomecareaides.com/documents/MAHomeCareAides.pdf. Accessed November 21, 2016.
18. Paraprofessional Health Institute. 2014. Home Health Aide Training Requirements by State. Available from: http://phinational.org/policy/home-health-aide-training-requirements-state. Accessed November 21, 2016.
19. Health Resources and Services Administration Health Workforce. 2012. Personal and Home Care Aide State Training (PHCAST) Demonstration Program: Report to Congress on Initial Implementation. Available from: https://www.hrsa.gov/about/organization/bureaus/bhw/reportstocongress/phcastreport.pdf. Accessed November 21, 2016.
20. Massachusetts Direct Care Workforce. 2016. About the Personal and Home Care Aide State Training Program. Available from: http://madirectcare.com/about-us/. Accessed November 21, 2016.
21. National Institute for Occupational Safety and Health (NIOSH). 2014. Caring for Yourself While Caring for Others: Training for Homecare Workers [DHHS (NIOSH) Publication Number 2015-102]. Available from: http://www.cdc.gov/niosh/docs/2015-102/default.html. Accessed September 28, 2016.
22. Paraprofessional Health Institute. 2013. Personal Care Aide Training Requirements: Summary of State Findings. Available from: http://phinational.org/sites/phinational.org/files/research-report/pca-training-reqs-state-findings.pdf. Accessed November 21, 2016.
23. The Personal Care Attendant Quality Home Care Workforce Council. 2014. 2014 Performance Review Report to the Governor and the General Court. Available from: http://www.mass.gov/pca/docs/annual-review-report-2014.pdf. Accessed November 21, 2016.
24. Quinn MM, Markkanen PK, Galligan CJ, Sama SR, Kriebel D, Gore RJ, et al. Occupational health of home care aides: results of the safe home care survey. Occup Environ Med 2016;73:237-45. doi:10.1136/oemed-2015-103031.
25. Markkanen P, Quinn M, Galligan C, Sama S, Brouillette N, Okyere D. Characterizing the nature of home care work and occupational hazards: a developmental intervention study. Am J Ind Med 2014;57:445-57. doi:10.1002/ajim.22287.
26. Centers for Disease Control and Prevention. 2012. 2007 National Home Health Aide Survey (NHHAS). Available from: http://www.cdc.gov/nchs/nhhas.htm. Accessed November 21, 2016.
27. Gershon RR, Dailey M, Magda LA, Riley HE, Conolly J, Silver A. Safety in the home healthcare sector: development of a new household safety checklist. J Patient Saf 2012;8:51-9. doi:10.1097/PTS.0b013e31824a4ad6.
28. Markkanen P, Quinn M, Galligan C, Chalupka S, Davis L, Laramie A. There's no place like home: a qualitative study of the working conditions of home health care providers. J Occup Environ Med 2007;49:327-37. doi:10.1097/JOM.0b013e3180326552.
29. Markkanen P, Chalupka SM, Galligan C, Sama SR, Gore RJ, Kim H, et al. Studying home health care nurses and aides: research design and challenges. J Res Nurs 2008;13:480-95. doi:10.1177/1744987108092055.
30. Kim H, Kriebel D, Quinn MM, Davis L. The Snowman: a model of injuries and near-misses for the prevention of sharps injuries. Am J Ind Med 2010;53:1119-27. doi:10.1002/ajim.20871.
31. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. Lancet 2016;387:1513-30. doi:10.1016/S0140-6736(16)00618-8.
32. Markkanen P, Galligan C, Laramie A, Fisher J, Sama S, Quinn M. Understanding sharps injuries in home healthcare: the Safe Home Care qualitative methods study to identify pathways for injury prevention. BMC Public Health 2015;15:359. doi:10.1186/s12889-015-1673-x.
33. Warner M, Schenker N, Heinen MA, Fingerhut LA. The effects of recall on reporting injury and poisoning episodes in the National Health Interview Survey. Inj Prev 2005;11:282-7. doi:10.1136/ip.2004.006965.