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Needlestick injuries among female veterinarians: frequency, syringe contents and side-effects

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In a mixed-mode survey of all 1970–80 female graduates of all US veterinary colleges, information was obtained regarding several health, personal and occupational factors including data on occupational needlestick events. Among the 2,532 survey respondents, 1,620 reported one or more needlesticks after graduation from veterinary college (64.0% of all respondents). A total of 2,663 stick events were reported, although the descriptions of each puncture event varied in quality/completeness, probably due in large part to their retrospective nature. Substances most often injected include vaccines, antibiotics, anaesthetics and animal blood. Of the 438 sticks resulting in at least one side-effect (16.4% of all sticks), 337 were classified as mild and localized at the site of injection (12.7% of all sticks, ~77% of sticks producing a side-effect), with 18 characterized as severe and systemic (0.7% of all sticks, ~4% of sticks producing a side-effect). One accidental self-injection of a prostaglandin compound resulted in a spontaneous abortion, heightening awareness that occupational needlesticks may also represent a serious human reproductive health hazard. The estimated overall needlestick injury rate for this group of health care professionals was 9.3 sticks per 100 person-years (PYs) of practice, comparable to reported rates among health care workers such as nurses, laboratory technicians and hospital housekeeping staff. Accounting for underreporting of the stick events, the actual injury rate is likely to be at least 20 sticks per 100 PYs. When stick rates were estimated by clinical practice type (small animal, large animal and mixed practice), all-small-animal and mixed-practice veterinarians demonstrated the highest rates, with all-large-animal practitioners demonstrating a rate lower by about 40%.

Key words: Occupational exposure; needlestick injuries; public health; veterinary medicine.

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INTRODUCTION

Puncture wounds caused by hypodermic needles were the second leading cause of occupational finger injuries treated in US emergency departments in 1982.[1] Because needlestick injuries may result in the transmission of infectious agents responsible for brucellosis, tuberculosis and other diseases,[2] epidemiologic studies of the phenomenon must be conducted to develop effective risk reduction strategies. Depending on the substance contained in the syringe at the time of the puncture event, a severe reaction or side-effect may occur.

It may be postulated that veterinarians are at higher risk of needlestick injury than other health care workers because they treat patients that are often uncooperative and difficult to communicate with. Since veterinarians use many of the same medications that are used in human health care, the results of side-effect studies may therefore be generalizable to health care workers who treat human patients. The study reported here was designed to estimate the rate of occurrence of needlestick events among female veterinarians and to examine the relationship between syringe contents and the nature of any resultant side-effects. While risk of

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needlestick injury is recognized in the context of the clinical practice of veterinary medicine,[3] empirical data on this phenomenon are lacking.

METHODS

Mixed-mode survey data collected by the Departments of Preventive Medicine* and Veterinary Preventive Medicine at The Ohio State University were used to examine the phenomenon of unintentional needlestick injury in the target population. The survey was designed to obtain data on a wide range of health, personal and environmental factors including history of occupational needlestick injuries. Attempts were made to identify all women graduating from all US veterinary colleges during the 11-year period 1970–80, as described in Wilkins *et al.*[4] A population of 2,997 was ascertained and located primarily using American Veterinary Medical Association membership files and US veterinary school graduation rosters. Following a standardized protocol, the survey was conducted in early 1987 *via* a self-administered mailed questionnaire.[5] A telephone follow-up survey of the mail non-respondents was conducted about one year later.

One questionnaire item was designed to determine if the respondent had ever experienced an unintentional inoculation or 'needlestick' since graduation from veterinary college ('Since your graduation from veterinary college, have you accidentally inoculated yourself or suffered an accidental needlestick?'). When an affirmative response to this question was given, details of each event experienced were requested, as follows: calendar year of the event, the substance contained in the needle or syringe and if any side-effects had occurred, an open-ended description of the side-effect(s).

All injected substances reported were identified and categorized into six general medication types as follows: vaccines, antibiotics, anaesthetics, euthanasia agents, anthelmintics and steroids. Additional categories were created for sterile syringes, syringes containing or contaminated by animal blood and other substances.

The self-reported side-effects were classified as either local or systemic, and mild or severe. Side-effects were also cross-classified with the substance categories and contingency table statistical analyses performed using either chi-square or Fisher's exact tests as appropriate.

Respondents were also questioned about their employment history since graduation from veterinary college. Information was obtained regarding the average number of hours worked per week in each job, the year each job started and ended and the clinical practice type of employment (all small animal, all large animal, mixed). This information was used along with the year of the event(s) to calculate needlestick injury rates as described below.

Denominators of needlestick injury rates were calculated by estimating the person-years (PYs) of time on the job contributed by responding cohort members. PYs were subclassified into the three clinical practice type categories indicated above, along with two other groupings: not in clinical practice and unknown/not stated. Each needlestick event and the total number of hours worked by each respondent were assigned to the clinical practice type that the veterinarian was working in when the stick occurred. In the calculation of PYs, it was assumed that 1 PY = 2,000 hours of work time. The needlestick events themselves as reported by the survey respondents were included in the numerator. To be consistent with other needlestick injury rates reported in the literature,[2] 100 PYs was used as the base.

RESULTS

Survey response. From the identified target population of 2,997 women veterinarians, it was possible to contact 2,807 (93.7%). Among the 2,807 individuals contacted, 2,532 completed the survey, by either mail or phone (2,427 and 105, respectively), for an overall response rate of 90.2% among those contacted.

Quality of needlestick data. As shown in Table 1, 1,618 (63.9%) of the 2,532 survey respondents provided 2,663 reports/descriptions of needlestick incidents. Not surprisingly, the quality of the information was not uniform, with year of graduation from veterinary college an important factor since this determined the years in practice and hence the recall period (see Table 2). It was possible to classify the 2,663 reports/descriptions as follows: in 1,428 reports (53.6%), the year of a single event was specified; in 338 reports (12.7%), the fact that a single event had occurred was reported but the year of occurrence was not; and in 897 (33.7%) reports, the respondent typically stated that she had been 'stuck more than once,' and that she could not recall the years. As shown in Table 2, a significant time trend is demonstrated in the frequency

Table 1. Reporting of needlestick events by a cohort of female veterinarians, 1970–87: raw data

No. stick 'reports'	*No. respondents*[a]	*% of 2,532*
0	914	36.1
1	923	36.5
2	443	17.5
3	175	6.9
4	56	2.2
5	21	0.8
Totals	2,532	100.0

[a] Number of respondents giving ≥ 1 stick report = 1,618 = 63.9% of 2,532.

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Table 2. Quality of reports of needlestick events, by year of graduation from veterinary college

Graduation year	Type of report								No. of reports
	Single event and year specified		Single event but year not specified		Year not specified but multiple sticks implied		Year not specified		
	No.	%	No.	%	No.	%	No.	%	
1970	21	29.8	4	5.6	47	65.3	51	70.8	72
1971	17	22.7	13	17.3	45	60.0	58	77.3	75
1972	38	42.2	15	16.7	37	41.1	52	57.8	90
1973	48	43.6	21	19.1	41	37.3	62	56.7	110
1974	68	50.4	20	14.8	47	34.8	67	49.6	135
1975	87	42.8	42	20.7	74	36.4	116	57.1	203
1976	121	46.4	53	20.3	87	33.3	140	53.6	261
1977	177	54.8	40	12.4	106	32.8	146	45.2	323
1978	234	60.3	42	10.8	112	28.9	154	39.7	388
1979	283	64.2	39	8.8	119	26.0	158	35.8	441
1980	334	59.1	49	8.7	182	32.2	231	40.9	565
Total	1,428	53.6	338	12.7	897	33.7	1,235	46.4	2,663

Table 3. Needlestick injury rate calculations for a cohort of female veterinarians, by clinical practice type

Clinical practice type	Reported sticks[a]	Imputed sticks[b]	Person-years	Rate 1[c]	Rate 2[d]
All small animal	377	799	3,854.0	9.8	20.7
Mixed	238	505	2,451.4	9.7	20.6
All large animal	47	100	804.0	5.8[e]	12.4
Not in clinical practice	34	73	1,023.0	3.3	7.1
Unknown/not stated	5	11	209.9	2.4	5.2
Total	701	1,488	8,342.3	8.4	17.8
Modified total[f]	662	1,404	7,109.4	9.3	19.7

[a] Based on reported single stick events where year of occurrence was given.

[b] Based on data provided by 1978–80 graduates only: Nine point one per cent of reports were single stick events with no year of occurrence given and 29.7% of reports were 'multiple stick' events with no year of occurrence given. For estimation purposes it was assumed each multiple stick event counted as two sticks.

[c] Rate 1 = [(Reported sticks)/(person-years)] x 100

[d] Rate 2 = [(Imputed sticks)/(person-years)] x 100

[e] Statistically significantly lower than all-small-animal or mixed rate ($p < 0.01$).

[f] Excludes not in clinical practice and unknown/not stated.

of reports containing a stated and usable year of occurrence.

Frequency of occurrence. Since significant underreporting of the needlestick events was evident, data provided by the 1978–80 graduates were used to estimate the needlestick occurrence rate. This minimized (but did not eliminate altogether) the impact of missing and incomplete data, and relied on three graduation years that accounted for more than one-half of the 1970–80 graduation cohort. As shown in Table 3, the overall rate of needlestick injury was found to be 9.3 sticks per 100 PYs (modified total 'rate 1' in Table 3). Based on the assumptions described in the Table 3 footnotes, the imputed number of sticks was used to estimate the overall 'rate 2,' which was found to be 19.7 sticks per 100 PYs. The all-small-animal and mixed-practice veterinarians exhibited the highest needlestick injury rates, and, among the veterinarians in some type of

Table 4. Syringe contents in 2,663 needlesticks among a cohort of female veterinarians

Syringe contents	Any side-effect reported?		All sticks	
	No.	%	No.	%
Vaccine	171	12.8	1,347	50.6
Antibiotic	36	14.6	252	9.5
Anaesthetic	79	68.5	207	7.8
Animal blood	23	18.1	130	4.9
Sterile needle	11	9.7	117	4.4
Euthanasia agent	47	41.6	113	4.2
Anthelmintic	20	52.6	38	1.4
Steroid	1	7.7	13	0.5
Other/N.S.	50	12.0	446	13.7
Total	438	16.4	2,663	100.0

[a] Percentage of contents-specific number of sticks. For example, of the 1,347 sticks involving vaccines, 171 (or 12.8% of 1,347) resulted in a side-effect.

clinical practice, the large-animal practitioners exhibited a rate about 40% lower ($p < 0.01$). Veterinarians not in clinical practice held jobs associated with some risk of occupational needlestick — for example, laboratory scientist — thus accounting for the lower observed rates of 3.3 and 7.1 sticks per 100 PYs in this CPT grouping.

Side-effects. Side-effects were reported in association with 438 (16.4%) of the 2,663 needlestick events (see Table 4). Classification of the events by syringe contents indicates that vaccines as a group were involved about half the time (50.6%). More than one-third of the vaccine-related sticks involved rabies vaccines and about 11% involved distemper vaccines. Antibiotics and anaesthetic agents were unintentionally injected 9.5% and 7.8% of the time, respectively, while animal blood, sterile needles and euthanasia agents were involved in 4–5% of the sticks. Anthelmintics and steroids were reported to have been involved only rarely

Table 5. Severity and extent of self-reported side-effects

Substance	*Severity of side-effect*				*Extent of side-effect*			
	Severe		*Mild*		*Systemic*		*Local*	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Vaccine	28	16.4	143	83.6	19	11.1	152	89.0
Antibiotic	4	11.1	32	88.9	0	0.0	36	100.0
Anaesthetic	4	5.1	74	94.9	23	29.5	55	70.5
Animal blood	4	17.4	19	82.6	2	8.7	21	91.3
Sterile needle	3	27.3	8	72.7	0	0.0	11	100.0
Euthanasia agent	8	17.0	39	83.0	8	17.0	39	83.0
Anthelmintic	0	0.0	20	100.0	1	5.0	19	95.0
Steroid	1	100.0	0	0.0	0	0.0	1	100.0
Other/N.S.	10	20.0	40	80.0	3	6.0	47	94.0
Total[a]	62	14.2	375	85.8	56	12.8	381	87.2

[a] Number of sticks does not total to 438 because of missing data.

Table 6. Frequency and nature of 37 side-effects from needlesticks reported by a cohort of female veterinarians, by severity and extent

Classification	*Local*			*Systemic*			*Totals*	
	Side-effect	*No.*	*(%)*[a]	*Side-effect*	*No.*	*(%)a*		
Mild	Local irritation, pain, swelling, soreness	270	(61.8)	Mild dizziness	15	(3.4)		
	Numbness	51	(11.7)	Worry	4	(0.9)		
	Haematoma	6	(1.4)	Headache	3	(0.7)		
	Severe bruising	5	(1.1)	Headache and dizziness	3	(0.7)		
	Slight bleeding	1	(0.2)	Mild drowsiness	3	(0.7)		
	Developed tendinitis at injection site	1	(0.2)	Local numbness, worry	3	(0.7)		
	Black eye	1	(0.2)	Fever, chills, achiness	3	(0.7)		
	Calcified injection site	1	(0.2)	Fever and headache	1	(0.2)		
	Wart-like lesion at injection site	1	(0.2)	Stress, anxiety, burnout	1	(0.2)		
				Nausea	1	(0.2)		
				Felt poor	1	(0.2)		
Subtotals		337	(76.9)		38	(8.7)	375	(85.8)
Severe	Severe swelling and inflammation	21	(4.8)	Brucellosis	9	(2.1)		
	Abscess formation	13	(3.0)	Severe allergic reaction	3	(0.7)		
	Joint infection	2	(0.5)	Mild allergic reaction	2	(0.5)		
	Local swelling of long duration (> 1 yr)	1	(0.2)	Psychedelic experience	2	(0.5)		
	Localized necrosis	1	(0.2)	Bronchial and laryngeal spasm	1	(0.2)		
	Skin slough	1	(0.2)	Miscarriage	1	(0.2)		
	Slough side of thumb	1	(0.2)					
	Corneal ulcer	1	(0.2)					
	Nerve damage (local)	1	(0.2)					
	Septic arthritis	1	(0.2)					
	Developed ringworm at injection site	1	(0.2)					
Subtotals		44	(10.0)		18	(4.1)	62	(14.2)
Totals		381	(87.2)		56	(12.8)	437	(100.0)

[a] Percentage of 437, the grand total.

(< 2% of the time). More than 90 specific substances were reported, by either generic or trade name.

Agents most likely to cause a side-effect included anthelmintics (52.6% of the anthelmintic sticks), euthanasia agents (41.6% of such sticks) and anaesthetics (38.5% of such sticks). It should be noted that one of the agents least likely to be involved in a stick (anthelmintics) was the most likely to produce some type of side-effect. On the other hand, the agent most likely involved in a stick incident (vaccine) resulted in a side-effect only about 13% of the time.

Results of classifying the 438 sticks where side-effects were reported are summarized in Table 5. The majority of the side-effects were mild in severity (85.8%) or localized in extent (87.2%). Vaccines were the most likely agents to cause a severe reaction (28/62 = 45.2%) while anaesthetics were the most likely to cause a systemic reaction (23/56 = 41.1%). It should be noted that vaccines were also commonly cited as being associated with systemic side-effects (19/56 = 33.9%).

Respondents reporting a stick-related side-effect described 37 different types of side-effects. As shown in Table 6, approximately 77% of all side-effects were mild in severity and local in the extent of the reaction; most of these (61.8% of all side-effects) were reported to have manifested as local irritation, pain, swelling and/or soreness. Numbness, severe swelling and inflammation, mild dizziness and abscess formation were also reported, accounting for 51 (11.7%), 21 (4.8%), 15 (3.4%) and 13 (3.0%) of the side-effects, respectively. Only 18 (4.1%) of the side-effects were classified as both severe and systemic, with brucellosis accounting for one-half of these. Arguably the most serious side-effect described was a miscarriage at week 15 of a pregnancy, which resulted from a needlestick where the syringe contained the prostaglandin dinoprost tromethamine.

DISCUSSION

The estimated needlestick injury rates in this group of female veterinarians appear similar to injury rates reported in previous studies of health care professionals.[2,6–17] As shown in Table 7 and Figure 1, injury rates exhibited by cohort members were generally similar to rates reported in previous studies of nurses,[7,9–13,16] physicians,[7,11,12,15] medical students,[6,12,17] hospital housekeeping staff,[7,9–13,16] hospital lab and pharmacy personnel[7,9–13] and emergency medicine technicians.[14] The difficulty in conducting such studies is evident in the extremely wide range of rates reported within several of the occupational groupings, *viz.*, nurses, pharmacy and physicians. Particularly troubling in this regard is the extremely wide range of stick rates reported among medical students, from 10.5 per 100 PYs[12] in one of the earliest studies, to 113.3 per 100 PYs[6] and 300 per 100 PYs.[17] In one respect, these results are not surprising given that underreporting of stick events is a serious problem[8] previously estimated to range anywhere from 39%[18] to 75%.[9] In the present study, the conservative assumptions applied to allow computation of the imputed number of sticks (and the corresponding injury rate) suggests the degree of underreporting is at least 50% among the female veterinarians in our study.

While it is plausible that differential recall of needlestick events across the CPT groupings could account for the much lower rate among the large-animal prac-

Figure 1. Needlestick injury rates among health care personnel

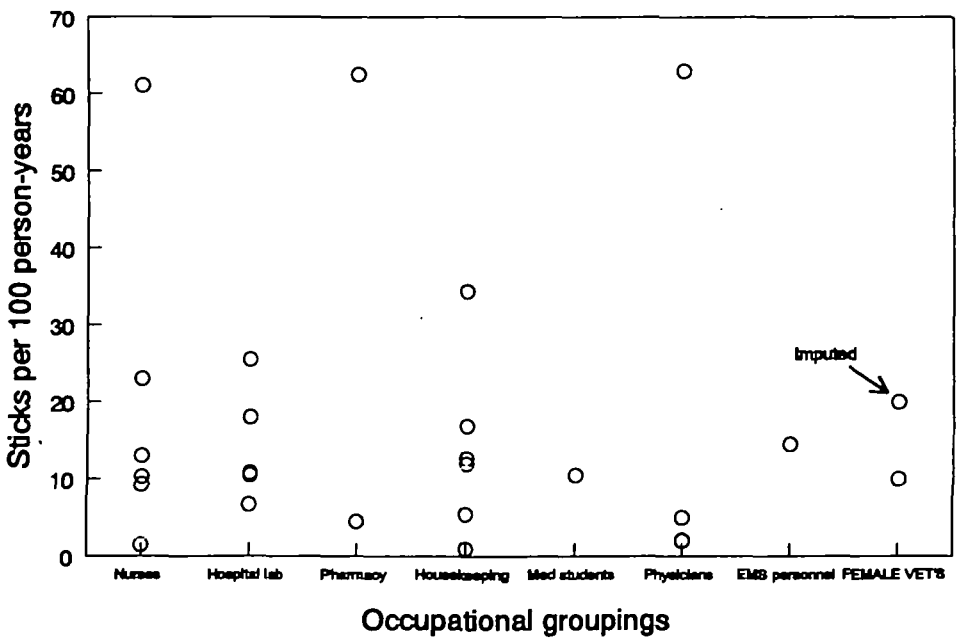

Table 7. Findings from previous studies of needlestick injuries among health care personnel[a]

Study	*Occupational grouping*							
	Nurses	*Hospital lab*	*Hospital pharmacy*	*House-keeping*	*Medical students*	*Physicians*	*EMS personnel*	*Female veterinarians*
Hamory 1983	61.1	25.5	62.5	34.4				
Osterman 1975	1.5			1.0				
Reed *et al.* 1980	13.0	10.8	4.5	16.9	10.5	2.0		
McCormick & Maki 1981	9.3	10.5		12.7				
Ruben *et al.* 1983	23.0	18.0		12.0		5.0		
Neuberger *et al.* 1984	10.0	6.7		10.9				
Newman 1986[b]	3.0			5.4				
Hochreiter & Barton 1988							14.5	
Gompertz 1990					(113.3)			
Heald & Ransohoff 1990						63.0		
Mansour 1990	10.3	20.4		5.5		2.1		
Wilkins & Bowman 1997								9.3, 19.7

[a]All rates in table per 100 person-years. All rates shown except one in parentheses plotted in Figure 1.

[b]Reported in Table 2 of Collins and Kennedy, 1987.

titioners, this would seem an unlikely or, at best, only a partial explanation. Future studies focused on the question of needlestick risks among veterinarians could address this by collecting detailed data over time on job tasks requiring the use of hypodermic needles and the animal species involved. Although speculative, the large-animal practitioners may experience a lower rate of needlestick puncture wounds because they are more likely to restrain their large-animal patients compared to the small-animal clinicians.

A related aspect is the error which may be created by a respondent's differential degree of recall of the details of the needlestick events. While this bias may be termed recall bias, it does not fit the classic definition.[19] In this case, it appears that veterinarians who have been out of school for a long period of time fail to recall or report the details of a particular event that occurred since that time, while those who have graduated more recently provide more detail. Deterioration of memory with the passage of time ('recall decay') is a well-documented phenomenon.[20] Furthermore, the presence of a side-effect appears to trigger better recall of the details of the past stick events: 77% of the needlesticks associated with a side-effect were reported with a specific year for that needlestick, while fewer than 50% of the needlesticks that did not result in a side-effect had a specific year reported for that needlestick (data not shown).

The association of syringe contents with side-effect production was statistically significant ($p < 0.001$), indicating empirically that some substances are more likely to cause a side-effect than others. Agents producing a side-effect most often include anthelmintics (52.6% of the time), euthanasia agents (41.6% of the time) and anaesthetics (38.5% of the time). At the other end of the spectrum, sticks involving sterile needles and steroids were reported to have produced side-effects less than 5% of the time (Table 4). Fortunately, most needlesticks did not result in severe or systemic side-effects. While only 16.4% of the reports of needlesticks included a description of a side-effect, potential side-effects should be a concern with a few of the substances. Although routine universal precautions need to be practised, the results of this study suggest that special care needs to be taken when using substances such as injectable prostaglandins, anthelmintic, euthanasia and anaesthetic agents. The euthanasia and anaesthetic agents are important not only because they frequently result in side-effects but because these side-effects are often systemic in nature. Finally, the unintentional injection of dinoprost tromethamine leading to miscarriage should serve to heighten awareness in the field that needlesticks may represent a significant reproductive health hazard. This should be a particularly well-heeded warning given the fact that the majority of veterinary students are now women.

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