

ONLINE TABLES

Development of a Job-Task-Exposure Matrix to assess occupational exposure to disinfectants among U.S. nurses

Quinot C, Dumas O, Henneberger PK, Varraso R, Wiley AS, Speizer FE, Goldberg M, Zock JP, Camargo CA Jr, Le Moual N

Table E1. Design of the 3 methods to evaluate occupational exposures by JEM and JTEM, example for exposure to hypochlorite bleach among emergency room nurses

Method 1: Based on the frequency of weekly exposure		Method 2: Based on the percentage of a score, combining frequency & intensity of exposure, greater than 2		Method 3: Based on the value of a weighted score using the frequency of exposure	
JEM 1 Job axis: 8 job types*	JTEM 1 “Job-Task” axis: 8 job types* x 3 tasks†	JEM 2 Job axis: 8 job types*	JTEM 2 “Job-Task” axis: 8 job types* x 3 tasks†	JEM 3 Job axis: 8 job types*	JTEM 3 “Job-Task” axis: 8 job types* x 3 tasks†
Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
38% of ER nurses reported weekly use of HB	39% of ER nurses who clean only surfaces reported weekly use of HB 56% of ER nurses who clean at least instruments reported weekly use of HB 4% of ER nurses without disinfecting tasks reported weekly use of HB	20% of ER nurses had a score ≥ 2 for HB	19% of ER nurses who clean only surface had a score ≥ 2 for HB 33% of ER nurses who clean at least instruments had a score ≥ 2 for HB 0% of ER nurses without disinfecting tasks had a score ≥ 2 for HB	ER nurses had a score of 105 for HB	ER nurses who clean only surfaces had a score of 108 for HB ER nurses who clean at least instruments had a score of 156 for HB ER nurses without disinfecting tasks had a score of 9 for HB
Cut-offs of Hypochlorite Bleach					
- 0 (low exposure): percentage less than 11% - 1 (medium exposure): percentage from 1% to 30.9% - 2 (high exposure): percentage greater or equal to 31%	- 0 (low exposure): less than 5% of score ≥ 2 - 1 (medium exposure): between 5 and 10.9 % of score ≥ 2 - 2 (high exposure): greater or equal to 11% of score ≥ 2	- 0 (low exposure): weighted score less than 24 - 1 (medium exposure): weighted score between 24 and 81.9 - 2 (high exposure): score greater or equal to 82			
38% is greater than 31% → ER nurses classified with high exposure to HB	39% is higher than 31% → ER nurses who clean only surfaces classified with high exposure to HB 56% is higher than 31% → ER nurses who clean at least instruments classified with high exposure to HB 4% is lower than 11% → ER nurses without disinfecting tasks classified with low exposure to HB	20% is greater than 11% → ER nurses classified with high exposure to HB	19% is higher than 11% → ER nurses who clean only surfaces classified with high exposure to HB 33% is higher than 11% → ER nurses who clean at least instruments were classified with high exposure to HB 0% is lower than 5% → ER nurses without disinfecting tasks are classified low exposure to HB	105 is greater than 82 → ER nurses classified with high exposure to HB	108 is higher than 82 → ER nurses who clean only surfaces classified with high exposure to HB 156 is higher than 82 → ER nurses who clean at least instruments classified with high exposure to HB 9 is lower than 24 → ER nurses without disinfecting tasks classified with low exposure to HB

HB: hypochlorite bleach; Frequency of exposure: 0:non-weekly exposed, 1:exposed 1-3 d/wk, 2:4-7 d/wk (Q14, Figure E2); Intensity: 1:exposed <1h/d, 2:1-4h/d, 3:>4h/d (Q15, Figure E2)

* Emergency room (ER), operating room, intensive care unit, other inpatient nurse, outpatient/community, other hospital nursing, nursing outside hospital, nursing education or administration ; † use disinfectants to clean surfaces only, to clean instruments (with/without surfaces), none

The first method of exposure assessment was based on the frequency of exposure in 2 categories (0:non-weekly exposed (never or <1 day/week), 1:exposed (1-3 or 4-7 days/week)). The second method was based on a score (ranged 0 to 6; 0:non-weekly exposed, 1:exposed 1-3 days/week(d/w) & <1 hour/day(h/d), 2:1-3 d/w & 1-4 h/d or 4-7d/w & <1h/d, 3:1-3 d/w & >4 h/d, 4:4-7 d/w & 1-4 h/d, 5:4-7 d/w & 1-4 h/d, 6:4-7 d/w & >4 h/d) combining frequency and intensity of exposure. The score was calculated for each nurse with the assumption that intensity was the same for all disinfectants used. Then, the score was classified in 3 levels: non-weekly exposed (score=0), low frequency and intensity of exposure (score=1), weekly exposed at moderate/high intensity (score ≥ 2). To design the JEM and the JTEM, the percentage of the category score ≥ 2 was used. The third method was based on a weighted score according to the frequency of exposure to specific chemicals using the frequency weighted by 2 (1-3 d/wk) and 5 (4-7 d/wk), e.g. 2*(% exposure 1-3 d/wk) + 5*(% exposure 4-7 d/wk).

Table E2. Cut-offs for the 3 methods

	Method 1			Method 2			Method 3		
	Self-reported weekly exposures (%)			Score ≥ 2 (%)			Weighted score based on exposure frequency		
	0 : Low exposure	1 : Medium exposure	2 : High exposure	0 : Low exposure	1 : Medium exposure	2 : High exposure	0 : Low exposure	1 : Medium exposure	2 : High exposure
Alcohol	<30	30-49.9	≥50	<10	10-20.9	≥21	<83	83-146.9	≥147
Hypochlorite bleach	<11	11-30.9	≥31	<5	5-10.9	≥11	<24	24-81.9	≥82
Peroxide bleach	<5	5-9.9	≥10	<5	5-9.9	≥10	<10	10-39.9	≥40
Glutaraldehyde	<5	5-9.9	≥10	<5	5-9.9	≥10	<10	10-39.9	≥40
Quaternary ammonium compounds	<5	5-18.9	≥19	<5	5-9.9	≥10	<15	15-60.9	≥61
Enzymatic cleaners	<5	5-9.9	≥10	<5	5-9.9	≥10	<10	10-39.9	≥40
Formaldehyde	<5	5-9.9	≥10	<5	5-9.9	≥10	<10	10-39.9	≥40
Use spray or aerosol	<10	10-22.9	≥23	<5	5-9.9	≥10	<24	24-65.9	≥66

Table E3. Description of the use of disinfectants per nursing jobs

	All (n=9,021)	Use of disinfectants for instruments or surfaces			
		Never (n=2,100)	<1 day/week (n=1,773)	1-3 days/week (n=2,956)	4-7 days/week (n=2,192)
Current job, %					
Emergency room	433	5.1	6.9	56.4	31.6
Operating room	1,068	5.8	13.7	33.0	47.5
Intensive care unit	760	4.6	13.8	63.8	17.8
Other inpatient nurse	1,155	11.2	17.7	46.7	24.4
Outpatient or community	2,074	26.2	20.6	27.2	26.0
Other hospital nursing	900	20.2	20.8	30.6	28.4
Nursing outside hospital	1,222	34.0	20.4	23.5	22.2
Nursing in education or administration	1,409	50.5	30.3	14.7	4.5

Weekly use: 1-3 days/week or 4-7 days/week

Table E4. Percentage of self-reported weekly use of disinfectants and spray, used to create Job- and Job-Task -Exposure Matrix - Method 1

Jobs	Tasks	n	Alcohol	Hypochlorite bleach	Peroxide bleach	Glutaraldehyde	Quats	Enzymatic cleaners	Formaldehyde	Spray			
			%	E	%	E	%	E	%	E			
Emergency Room	JEM1	433	45.9	1	37.9	2	20.6	2	11.5	2	21.4	2	
	JTEM1	Clean only surfaces	287	47.5	1	38.9	2	18.7	2	11.5	2	21.6	2
		Clean at least instruments*	91	63.5	2	56.1	2	37.5	2	18.0	2	32.6	2
		No disinfecting tasks	49	10.6	0	4.4	0	4.4	0	0.0	0	2.1	0
Operating Room	JEM1	1,074	47.7	1	24.0	1	17.1	2	11.3	2	19.9	2	
	JTEM1	Clean only surfaces	574	45.8	1	23.7	1	15.8	2	10.4	2	24.1	2
		Clean at least instruments*	279	67.9	2	36.0	2	28.1	2	19.5	2	22.8	2
		No disinfecting tasks	204	25.0	0	9.1	0	5.6	1	2.6	0	4.6	0
Intensive Care Unit	JEM1	763	56.9	2	37.7	2	12.1	2	8.8	1	23.7	2	
	JTEM1	Clean only surfaces	306	56.4	2	35.3	2	9.9	1	6.6	1	28.0	2
		Clean at least instruments*	310	68.4	2	51.1	2	18.5	2	14.6	2	23.9	2
		No disinfecting tasks	134	32.6	1	14.3	1	3.8	0	2.3	0	13.4	1
Other Inpatient nurse	JEM1	1,158	51.0	2	31.9	2	8.5	1	7.6	1	17.1	1	
	JTEM1	Clean only surfaces	443	50.7	2	29.1	1	7.1	1	9.0	1	21.6	2
		Clean at least instruments*	367	66.3	2	53.8	2	13.7	2	11.9	2	21.3	2
		No disinfecting tasks	330	33.7	1	11.4	1	4.4	0	1.6	0	6.0	1
Outpatient or community	JEM1	2,086	42.1	1	17.8	1	8.0	1	7.7	1	13.6	1	
	JTEM1	Clean only surfaces	709	50.0	2	26.8	1	9.7	1	10.0	2	22.5	2
		Clean at least instruments*	387	67.0	2	36.6	2	20.5	2	22.5	2	24.5	2
		No disinfecting tasks	957	26.6	0	4.1	0	1.6	0	0.6	0	2.8	0
Other hospital nursing	JEM1	904	33.6	1	21.0	1	8.8	1	9.1	1	14.0	1	
	JTEM1	Clean only surfaces	359	39.5	1	23.4	1	10.4	2	9.3	1	20.2	2
		Clean at least instruments*	165	66.9	2	48.1	2	21.6	2	25.2	2	25.8	2
		No disinfecting tasks	365	13.5	0	7.0	0	1.9	0	2.2	0	2.5	0
Nursing outside hospital	JEM1	1,233	36.1	1	18.9	1	7.8	1	6.1	1	8.1	1	
	JTEM1	Clean only surfaces	351	50.0	2	33.0	2	11.5	2	7.9	1	16.9	1
		Clean at least instruments*	202	68.7	2	41.1	2	20.0	2	21.1	2	16.7	1
		No disinfecting tasks	658	18.9	0	4.8	0	2.3	0	0.5	0	1.1	0
Nursing in education or administration	JEM1	1,422	16.5	0	10.0	0	3.2	0	1.4	0	4.0	0	
	JTEM1	Clean only surfaces	226	48.4	1	34.4	2	13.3	2	4.2	0	14.2	1
		Clean at least instruments*	45	59.1	2	63.6	2	9.3	1	7.1	1	13.9	1
		No disinfecting tasks	1,128	8.6	0	3.1	0	0.8	0	0.5	0	1.7	0

Results are presented, for each disinfectant, as % of self-reported weekly use, and corresponding JEM / JTEM exposure level estimate. Exposure was evaluated in 3 classes (0: low; 1: medium; 2: high) using product-specific cut-offs defined from the distribution of the percentage of self-reported exposure per job and tasks.

*Most nurses in this category reported cleaning instrument and surfaces. Results presented as percentages, unless otherwise specified. Quats: Quaternary ammonium compounds

Table E5. Comparison of JEM and JTEM exposure assessments by hospital units - Method 1

		n	Alcohol	Hypochlorite bleach	Peroxide bleach	Glutaraldehyde	Quats	Enzymatic cleaners	Formaldehyde	Spray
Emergency Room	JEM 1	427	Medium	High	High	High	High	Low	Low	High
	JTEM1	Low, %	12	11	11	11	11	79	100	11
		Medium, %	67	0	0	0	0	0	0	0
Operating Room	JEM 1	1,057	Medium	Medium	High	High	High	High	High	High
	JTEM1	Low, %	19	19	0	0	0	0	0	0
		Medium, %	54	54	19	19	19	19	0	19
Intensive Care Unit	JEM 1	750	High	High	High	Medium	High	Low	Low	Medium
	JTEM1	Low, %	0	0	18	18	0	100	100	18
		Medium, %	18	18	41	41	18	0	0	82
Other Inpatient nurse	JEM 1	1,140	High	High	Medium	Medium	Medium	Low	Low	Medium
	JTEM1	Low, %	0	0	29	29	0	68	100	29
		Medium, %	29	68	39	39	29	32	0	39
Outpatient or community	JEM 1	2,053	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium
	JTEM1	Low, %	47	47	47	47	47	81	81	47
		Medium, %	0	34	34	0	0	0	19	0
Other hospital nursing	JEM 1	889	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium
	JTEM1	Low, %	41	41	41	41	41	81	81	41
		Medium, %	40	40	0	40	0	0	0	40
Nursing outside hospital	JEM 1	1,211	Medium	Medium	Medium	Medium	Medium	Low	Low	High
	JTEM1	Low, %	54	54	54	54	54	83	100	54
		Medium, %	0	0	0	29	46	0	0	0
Nursing in education or administration	JEM 1	1,399	Low	Low	Low	Low	Low	Low	Low	Low
	JTEM1	Low, %	81	81	81	97	81	100	100	81
		Medium, %	16	0	3	3	19	0	0	0
		High, %	3	19	16	0	0	0	0	19

0: low exposure; 1: medium; 2: high; Quats: Quaternary ammonium compounds

Table E6. Comparison of the three methods to evaluate JEM and JTEM exposure

			Alcohol	Hypochl. Bleach	Peroxyde Bleach	Glutaraldehyde	Quats	Enzyme cleaners	Formaldehyde	Sprays
Emergency Room	JTEM 1/2/3	JEM 1/2/3	1/2/1	2/2/2	2/1/2	2/1/1	2/2/2	0/0/0	0/0/0	2/2/2
		Clean only surfaces	1/2/1	2/2/2	2/1/2	2/1/1	2/2/2	0/0/0	0/0/0	2/2/1
		Clean at least instruments*	2/2/2	2/2/2	2/2/2	2/2/2	2/2/2	2/1/1	0/0/0	2/2/2
Operating Room	JTEM 1/2/3	No disinfecting tasks	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
		JEM 1/2/3	1/2/2	1/2/1	2/1/2	2/1/1	2/2/2	2/1/2	2/2/2	2/2/2
		Clean only surfaces	1/2/2	1/2/1	2/1/2	2/1/1	2/2/2	2/1/2	2/2/2	2/2/2
Intensive Care Unit	JTEM 1/2/3	Clean at least instruments*	2/2/2	2/2/2	2/2/2	2/2/2	2/2/2	2/2/2	2/2/2	2/2/2
		No disinfecting tasks	0/0/0	0/0/0	1/0/1	0/0/0	0/0/0	1/0/1	2/0/1	1/0/1
		JEM 1/2/3	2/1/2	2/1/2	2/0/1	1/0/1	2/1/2	0/0/0	0/0/0	1/1/1
Other Inpatient nurse	JTEM 1/2/3	Clean only surfaces	2/1/2	2/1/2	1/0/1	1/0/1	2/1/2	0/0/0	0/0/0	1/0/1
		Clean at least instruments*	2/2/2	2/2/2	2/1/2	2/1/1	2/1/2	0/0/0	0/0/0	1/1/1
		No disinfecting tasks	1/0/1	1/0/1	0/0/0	0/0/0	1/0/1	0/0/0	0/0/0	0/0/0
Outpatient or community	JTEM 1/2/3	JEM 1/2/3	2/1/2	2/1/2	1/0/1	1/0/1	1/1/1	0/0/0	0/0/0	1/1/1
		Clean only surfaces	2/1/1	1/1/1	1/0/1	1/0/1	2/1/2	0/0/0	0/0/0	1/1/1
		Clean at least instruments*	2/2/2	2/2/2	2/0/1	2/0/1	2/1/2	1/0/1	0/0/0	2/2/2
Other hospital nursing	JTEM 1/2/3	No disinfecting tasks	1/1/1	1/0/1	0/0/0	0/0/0	1/0/1	0/0/0	0/0/0	0/0/0
		JEM 1/2/3	1/2/1	1/1/1	1/0/1	1/0/1	1/1/1	0/0/1	0/0/0	1/1/1
		Clean only surfaces	1/1/1	1/2/1	2/1/1	1/0/1	2/2/2	0/0/1	0/0/1	1/2/2
Nursing outside hospital	JTEM 1/2/3	Clean at least instruments*	2/2/2	2/2/2	2/1/2	2/2/2	2/2/2	2/1/2	1/1/1	2/2/2
		No disinfecting tasks	0/1/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/1
		JEM 1/2/3	1/1/1	1/1/1	1/0/1	1/1/1	1/1/1	0/0/1	0/0/1	1/1/1
Nursing in education or administration	JTEM 1/2/3	Clean only surfaces	1/1/1	1/2/1	2/1/1	1/0/1	2/2/2	0/0/1	0/0/1	1/2/2
		Clean at least instruments*	2/2/2	2/2/2	2/1/2	2/2/2	2/2/2	2/2/2	2/2/1	2/2/2
		No clean	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0

Method 1 (JEM 1 and JTEM 1) was defined by taking into account the percentage of participants reporting weekly exposure;

Method 2 (JEM 2 and JTEM 2) was defined from a score combining frequency & intensity of exposure;

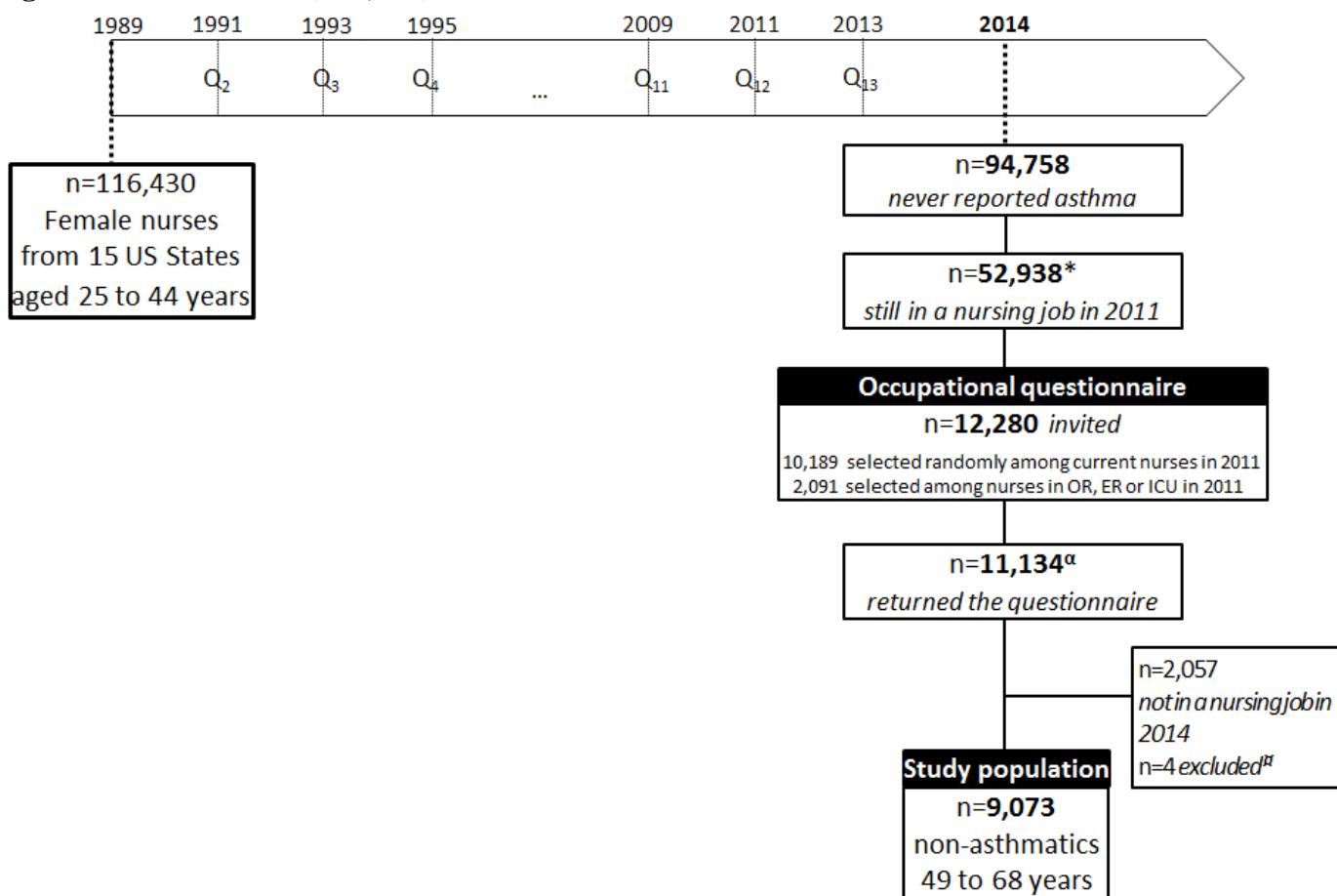
Method 3 (JEM 3 and JTEM 3) was defined from weighted score using the reported exposure frequency (see Tables E1 and E3 for more details)

(0: low exposure; 1: medium; 2: high)

Table E7. Comparison of self-report, JEM and JTEM exposure assessment according to age - Method 1

n=9,073	Self-report		JEM1		JTEM1	
	%		exposure evaluation	%	exposure evaluation	%
Days/weeks	1-3 days/week	4-7 days/week	medium	high	medium	high
49-54 years (n=2,045)						
Alcohol	25	15	61	24	22	46
Hypochlorite Bleach	19	6	55	29	28	40
Peroxide Bleach	7	3	57	28	19	45
Glutaraldehyde	6	2	68	17	17	43
Quaternary ammonium compounds	10	7	57	28	15	53
Enzymatic cleaners	3	2	0	11	7	21
Formaldehyde	2	3	0	11	5	14
Spray	13	6	56	28	19	45
55-59 years (n=3,517)						
Alcohol	24	16	64	21	21	43
Hypochlorite Bleach	15	7	60	25	29	35
Peroxide Bleach	7	3	59	26	21	41
Glutaraldehyde	5	2	67	18	17	40
Quaternary ammonium compounds	8	5	59	26	15	50
Enzymatic cleaners	3	1	0	13	7	20
Formaldehyde	3	3	0	13	5	15
Spray	12	7	53	32	18	44
≥ 60 years (n=3,511)						
Alcohol	26	13	64	20	21	36
Hypochlorite Bleach	15	5	59	24	28	29
Peroxide Bleach	7	2	61	22	18	36
Glutaraldehyde	5	2	68	15	17	33
Quaternary ammonium compounds	8	4	61	22	14	43
Enzymatic cleaners	3	1	0	11	6	17
Formaldehyde	3	2	0	11	4	12
Spray	14	6	54	30	17	37

Figure E1. Flow-Chart (n=9,073)



* About 73% of them were eligible to receive a supplemental questionnaire.

Eligibility was defined by having returned the 2013 biennial questionnaire at the time the supplemental questionnaire invites were sent, and not being already enrolled in another sub-study. Eligible nurses and non-eligible nurses were similar regarding the use of disinfectants in 2011.

^a 91% had returned a questionnaire (9,248 for the random sample, 1,886 for the enriched sample). Enriched sample: selected at random among nurses in ER, OR and ICU (more exposed to disinfectants) in 2011.

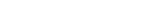
[#] Decline sharing of data for this project

ER: emergency room nurse; OR: operating room nurses; ICU: intensive care unit nurses

Figure E2. Extract of the questionnaire

1. Which best describes your current employment status?

ER OR ICU Other inpatient nurse Nursing education or admin
 Outpatient or community Other hospital nursing Nursing outside hospital
 Non-nursing employment F/T homemaker Disabled Retired Other

If you reported non-nursing employment, fulltime homemaker, disabled, retired, or other, what year did you finish your last nursing job? 

Thinking about your **current job** and the use of **disinfectants** (such as ethylene oxide, hydrogen peroxide, ortho-phthalaldehyde, formaldehyde, glutaraldehyde, bleach):

4. On how many days per week, on average, do you clean medical instruments with disinfectants?
 Never <1 day/week 1–3 days/week 4–7 days/week

5. On how many days per week, on average, do you clean surfaces (like floors, tables) at work with disinfectants?
 Never <1 day/week 1–3 days/week 4–7 days/week

14. On how many days per week do you use the following <u>disinfectants</u> at work?	Number of days per week			
	Never	<1 day per week	1-3 days per week	4-7 days per week
a) Formaldehyde	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Glutaraldehyde (e.g., Cidex, Metricide, Rapicide, Wavicide, Aldahol III)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Ortho-phthalaldehyde (e.g., Cidex OPA, Metricide OPA Plus, Opaciden)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Hypochlorite bleach, chlorine (e.g., Clorox)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Peroxide bleach, hydrogen peroxide (e.g., Accell, Optim, Resert XL, Sporox, Acecide, EndoSpor Plus, Peract, Sterad)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Peracetic acid (e.g., Steris)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Acetic acid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) Alcohol [ethanol, methanol, isopropanol]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) Ammonia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j) Quaternary ammonium compounds, "Quats" (e.g. 3M Neutral Quat 23, 3M HB Quat 25, Oasis Multi-Quat, Staphene, BTC100, BioQuat, Sentinel, Virex)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k) Ethylene oxide (e.g., in compressed-gas cylinders, single-dose cartridges or glass ampules)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l) Chloramine T	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m) Phenolics (e.g., 3M Phenolic Disinfectant 18, WexCide, MicroBakII, Megacide, Novigard, Expose II 256)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n) Enzymatic cleaners (e.g., Asepti-Zyme, 3M Rapid Multi-Enzyme)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o) 'Green' products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If you don't know the active compound:				
p) Fill in the brand name below				

15. On days with disinfectant use, how many hours, on average, do you use disinfectants?

Less than 1 hour a day 1-4 hours per day More than 4 hours a day