

SUPPLEMENTARY MATERIAL:**Occupational risk factors and exposure-response relationships for airway disease among health workers exposed to cleaning agents in tertiary hospitals**

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Table S1: Cleaning-related tasks and control measures reported in the two hospitals

	South Africa n (%)	Tanzania n (%)
No. of Departments investigated	36	13
Cleaning-related tasks performed*		
Hand washing / sanitising	36 (100)	13 (100)
Fixed surfaces cleaning and disinfection	35 (97)	13 (100)
Medical instruments cleaning and disinfection	20 (56)	13 (100)
Patients' skin / wound cleaning and disinfection	31 (86)	12 (92)
Floor finishing tasks (stripping, waxing, buffing)	36 (100)	0 (0)
Specimen preparation	19 (53)	8 (62)
The manner of cleaning products use: used more sprays or more wipes*		
More wipes than sprays	32 (89)	13 (100)
More sprays than wipes	3 (8)	0 (0)
Use sprays and wipes about equally	1 (3)	0 (0)
Control measures uptake		
Engineering controls present*		
Extractor fans in the ceiling	30 (83)	2 (15)
Local exhaust ventilation system	0 (0)	0 (0)
Administrative controls present		
Training on adverse health effects due to cleaning agents**	16 (44)	3 (23)
Availability of Standard Operating Procedures document/s on how to use cleaning agents*	13 (36)	11 (85)
Housekeeping: Chemical spill / release observed*	0 (0)	1 (8)
Personal protective equipment use*		
Gloves	36 (100)	13 (100)
Protective clothing (aprons, overalls)	29 (81)	3 (23)
Eye protection (goggles, face shields)	2 (6)	0 (0)
Foot protection (safety/gum boots)	1 (3)	3 (23)
Air purifying half face respirator	0 (0)	0 (0)
Medical surveillance programme**	0 (0)	0 (0)

*: Information from walk-through surveys; **: Information from interviews with nurse managers

Table S2: Commonly used cleaning products in the two hospitals

	South Africa		Tanzania	
	N = 36 departments		N = 13 departments	
Medical instruments cleaning & disinfection	N = 20	n (%)	N = 13	n (%)
	Enzymatic cleaners	15 (42)	Bleach	10 (77)
	Ortho-phthalaldehyde	13 (36)	All-purpose cleaner	10 (77)
	Alcohols	7 (19)	Enzymatic cleaners	5 (39)
	Chlorhexidine	6 (17)	Glutaraldehyde	4 (31)
	Hydrogen peroxide	5 (14)	Ortho-phthalaldehyde	3 (23)
Fixed surfaces cleaning & disinfection	N = 35	n (%)	N = 13	n (%)
	Bleach	34 (94)	Bleach	13 (100)
	Ammonia	33 (92)	All-purpose cleaner	13 (100)
	Alcohols	31 (86)	Glass cleaner	7 (54)
	Dishwashing liquid	29 (81)	Floor cleaner	2 (15)
	Air freshener	21 (58)		
Floor finishing tasks (stripping, waxing & buffing)	N = 36	n (%)	N = 0	n (%)
	Floor stripper [#]	36 (100)		
	Floor wax [*]	36 (100)		
Specimen preparation	N = 19	n (%)	N = 8	n (%)
	Formalin 10% solution	18 (50)	Formalin 10% solution	8 (62)
	Cytological fixative spray	14 (39)		
	Alcohol solution	3 (8)		
	Glutaraldehyde	1 (3)		
Patients' skin / wound cleaning & disinfection	N = 31	n (%)	N = 12	n (%)
	Alcohols	27 (75)	Alcohols	12 (92)
	Chlorhexidine	22 (61)	Povidone iodine	11 (85)
	Povidone iodine	15 (42)	Chloroxylonol	4 (31)
	Ether	6 (17)	Hydrogen peroxide mouthwash	1 (8)
Hand washing / sanitising	N = 36	n (%)	N = 12	n (%)
	Chlorhexidine	36 (100)	All-purpose cleaner (diluted)	12 (92)
	Liquid hand soap	33 (92)	Alcohol sanitiser	8 (62)
	Alcohol sanitiser	27 (75)	Hand wash liquid soap	1 (8)
	Povidone iodine	6 (17)		

N = number of departments assessed; n = number of departments conducting the task/s; * = duration of buff sprays (diluted floor wax); # = Floor strippers were used only once a year in each department in the SAH

Table S3: Respiratory symptoms and airway inflammation associated with specific medical instrument cleaning and disinfection agents in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb* (n = 654)	FeNO ≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Medical instruments cleaning and disinfection	301 (43)	1.14 (0.85 – 1.52)	1.06 (0.67 – 1.68)	1.26 (0.83 – 1.92)	0.75 (0.41 – 1.40)	1.06 (0.96 – 1.17)	1.34 (0.70 – 2.59)
Ortho-phthalaldehyde							
Yes vs No	113 (16)	1.09 (0.75 – 1.60)	0.84 (0.45 – 1.58)	1.55 (0.92 – 2.60)	0.73 (0.30 – 1.77)	1.10 (0.96 – 1.25)	2.81 (1.32 – 5.94)**
0 minutes / week	584 (86)	1	1	1	1	1	1
1 – 99 minutes / week	64 (10)	1.28 (0.80 – 2.05)	1.10 (0.52 – 2.32)	1.05 (0.51 – 2.16)	0.62 (0.18 – 2.07)	1.19 (1.01 – 1.40)*	3.73 (1.60 – 8.73)**
≥ 100 minutes / week	30 (4)	1.15 (0.58 – 2.26)	0.72 (0.21 – 2.47)	3.22 (1.43 – 7.25)**	1.47 (0.42 – 5.16)	0.98 (0.78 – 1.23)	0.77 (0.10 – 6.02)
Glutaraldehyde							
Yes vs No	49 (7)	1.03 (0.59 – 1.81)	1.17 (0.50 – 2.75)	1.42 (0.68 – 2.96)	1.14 (0.39 – 3.37)	0.89 (0.73 – 1.07)	0.88 (0.26 – 3.02)
0 minutes / week	648 (94)	1	1	1	1	1	1
1 – 99 minutes / week	28 (4)	1.14 (0.56 – 2.30)	1.18 (0.39 – 3.57)	0.66 (0.20 – 2.24)	1.00 (0.23 – 4.40)	0.93 (0.73 – 1.18)	1.18 (0.26 – 5.30)
≥ 100 minutes / week	16 (2)	0.79 (0.27 – 2.34)	1.07 (0.23 – 4.93)	4.47 (1.61 – 12.45)**	2.02 (0.43 – 9.47)	0.88 (0.64 – 1.23)	0.79 (0.10 – 6.35)
Enzymatic cleaners							
Yes vs No	113 (16)	1.16 (0.80 – 1.70)	1.17 (0.65 – 2.10)	1.20 (0.70 – 2.06)	1.39 (0.66 – 2.91)	1.12 (0.99 – 1.28)	2.20 (1.04 – 4.65)*
0 minutes / week	584 (87)	1	1	1	1	1	1
1 – 99 minutes / week	46 (7)	1.52 (0.89 – 2.59)	1.72 (0.78 – 3.80)	0.66 (0.25 – 1.74)	1.64 (0.60 – 4.47)	1.18 (0.97 – 1.43)	3.90 (1.53 – 9.98)**
≥ 100 minutes / week	43 (6)	1.15 (0.64 – 2.09)	0.95 (0.36 – 2.54)	2.59 (1.29 – 5.20)**	1.18 (0.34 – 4.05)	1.00 (0.82 – 1.22)	0.98 (0.22 – 4.37)
Chlorhexidine							
Yes vs No	84 (12)	1.26 (0.83 – 1.92)	0.85 (0.43 – 1.71)	0.66 (0.33 – 1.34)	0.61 (0.21 – 1.76)	1.31 (1.13 – 1.51)***	2.13 (0.91 – 4.99)
0 minutes / week	613 (91)	1	1	1	1	1	1
1 – 99 minutes / week	44 (7)	1.41 (0.81 – 2.45)	0.64 (0.22 – 1.87)	0.64 (0.25 – 1.69)	NC	1.38 (1.14 – 1.66)**	2.91 (1.02 – 8.35)*
≥ 100 minutes / week	13 (2)	1.54 (0.60 – 3.95)	0.94 (0.20 – 4.41)	1.52 (0.41 – 5.71)	0.96 (0.12 – 7.78)	1.11 (0.79 – 1.55)	NC

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: Geometric mean ratio (95% Confidence Interval); NC: not calculable
Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;

WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;

WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work.

Table S3 (contd.): Respiratory symptoms and airway inflammation associated with specific medical instrument cleaning and disinfection agents in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [†] (n = 654)	FeNO ≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Quaternary ammonium compounds							
Yes vs No	26 (4)	1.02 (0.49 – 2.13)	1.41 (0.49 – 4.02)	0.91 (0.30 – 2.74)	2.09 (0.59 – 7.44)	1.20 (0.94 – 1.53)	2.77 (0.75 – 10.21)
0 minutes / week	671 (97)	1	1	1	1	1	1
1 – 99 minutes / week	15 (2)	0.84 (0.29 – 2.42)	0.99 (0.21 – 4.75)	0.34 (0.04 – 2.69)	NC	1.26 (0.92 – 1.74)	5.31 (1.32 – 21.28)*
≥ 100 minutes / week	3 (1)	1.83 (0.29 – 11.57)	2.94 (0.25 – 34.30)	12.08 (1.05 – 138.76)*	8.34 (0.62 – 111.58)	1.50 (0.74 – 3.04)	NC
Hydrogen peroxide							
Yes vs No	40 (6)	1.44 (0.81 – 2.56)	1.48 (0.62 – 3.53)	1.66 (0.76 – 3.61)	3.14 (1.29 – 7.66)*	1.11 (0.91 – 1.37)	2.51 (0.90 – 7.04)
0 minutes / week	657 (95)	1	1	1	1	1	1
1 – 99 minutes / week	27 (4)	1.71 (0.87 – 3.36)	1.91 (0.73 – 5.03)	2.01 (0.82 – 4.95)	2.99 (1.06 – 8.45)*	1.14 (0.88 – 1.46)	1.96 (0.54 – 7.06)
≥ 100 minutes / week	7 (1)	0.97 (0.21 – 4.48)	NC	1.05 (0.12 – 8.91)	NC	0.97 (0.61 – 1.55)	4.29 (0.46 – 40.10)
Alcohols							
Yes vs No	104 (15)	0.93 (0.62 – 1.39)	0.81 (0.42 – 1.57)	1.07 (0.60 – 1.90)	0.75 (0.31 – 1.82)	1.01 (0.89 – 1.16)	1.42 (0.62 – 3.24)
0 minutes / week	593 (88)	1	1	1	1	1	1
1 – 99 minutes / week	64 (10)	1.03 (0.63 – 1.69)	1.02 (0.48 – 2.18)	0.56 (0.23 – 1.35)	0.78 (0.27 – 2.29)	1.01 (0.85 – 1.19)	1.75 (0.68 – 4.49)
≥ 100 minutes / week	16 (2)	1.12 (0.45 – 2.80)	0.93 (0.20 – 4.26)	4.40 (1.58 – 12.26)**	0.85 (0.11 – 6.75)	1.21 (0.89 – 1.65)	1.25 (0.15 – 10.17)
Bleach							
Yes vs No	204 (29)	0.91 (0.66 – 1.26)	0.86 (0.51 – 1.44)	1.21 (0.77 – 1.90)	0.74 (0.37 – 1.47)	0.90 (0.81 – 1.00)	0.71 (0.34 – 1.50)
0 minutes / week	493 (75)	1	1	1	1	1	1
1 – 99 minutes / week	89 (14)	0.96 (0.63 – 1.48)	0.82 (0.40 – 1.69)	0.72 (0.35 – 1.47)	0.26 (0.06 – 1.11)	0.94 (0.81 – 1.08)	0.67 (0.23 – 1.98)
≥ 100 minutes / week	75 (11)	0.88 (0.55 – 1.43)	0.80 (0.36 – 1.78)	2.50 (1.41 – 4.43)**	1.36 (0.60 – 3.09)	0.87 (0.75 – 1.02)	0.72 (0.24 – 2.13)

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Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;

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WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work.

Table S4: Respiratory symptoms and airway inflammation associated with specific medical instrument cleaning and disinfection tasks in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [*] (n = 654)	FeNO _≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Medical instruments cleaning and disinfection	301 (43)						
Medical instruments cleaning & disinfecting tasks ^{**}	331 (48)	1.31 (0.97 – 1.75)	1.28 (0.81 – 2.03)	1.07 (0.70 – 1.64)	0.90 (0.49 – 1.65)	1.13 (1.03 – 1.25)*	1.55 (0.80 – 3.02)
Manually disassembling instruments, removing/flushing gross contaminants							
Yes vs No	201 (29)	1.41 (1.04 – 1.92)*	1.31 (0.81 – 2.12)	1.08 (0.69– 1.70)	1.14 (0.60 – 2.17)	1.14 (1.03 – 1.27)*	1.69 (0.85 – 3.37)
0 minutes / week	496 (71)	1	1	1	1	1	1
1 – 99 minutes / week	133 (19)	1.44 (1.01 – 2.07)*	1.42 (0.82 – 2.46)	0.78 (0.44– 1.39)	1.17 (0.55 – 2.47)	1.18 (1.05 – 1.34)**	2.02 (0.94 – 4.37)
≥ 100 minutes / week	68 (10)	1.34 (0.84 – 2.14)	1.10 (0.51 – 2.37)	1.77 (0.95 – 3.29)	1.09 (0.40 – 2.92)	1.06 (0.90 – 1.26)	1.18 (0.39 – 3.57)
Diluting or mixing cleaning products							
Yes vs No	251 (36)	1.20 (0.89 – 1.61)	1.09 (0.68 – 1.74)	1.24 (0.81 – 1.90)	0.96 (0.51 – 1.78)	1.06 (0.96 – 1.17)	1.32 (0.68 – 2.56)
0 minutes / week	446 (64)	1	1	1	1	1	1
1 – 99 minutes / week	213 (31)	1.19 (0.87 – 1.63)	1.12 (0.69 – 1.82)	1.22 (0.78 – 1.91)	0.99 (0.52 – 1.90)	1.03 (0.93 – 1.14)	1.26 (0.63 – 2.54)
≥ 100 minutes / week	38 (5)	1.20 (0.65 – 2.23)	0.94 (0.34 – 2.57)	1.35 (0.56 – 3.24)	0.74 (0.17 – 3.26)	1.23 (0.99 – 1.53)	1.70 (0.47 – 6.18)
Changing sterilisation solutions							
Yes vs No	157 (23)	1.40 (1.00 – 1.94)*	1.36 (0.81 – 2.29)	1.49 (0.93 – 2.38)	0.79 (0.37 – 1.70)	1.05 (0.93 – 1.17)	1.24 (0.58 – 2.64)
0 minutes / week	540 (78)	1	1	1	1	1	1
1 – 99 minutes / week	135 (19)	1.48 (1.04 – 2.08)*	1.56 (0.92 – 2.68)	1.21 (0.72 – 2.04)	0.80 (0.36 – 1.78)	1.02 (0.91 – 1.16)	1.30 (0.59 – 2.86)
≥ 100 minutes / week	22 (3)	0.89 (0.37– 2.15)	0.34 (0.04 – 2.59)	3.97 (1.55 – 10.15)**	0.75 (0.10 – 5.83)	1.19 (0.90 – 1.57)	0.89 (0.11 – 7.08)
Manually sterilise/disinfection of medical instruments							
Yes vs No	143 (21)	1.45 (1.03 – 2.03)*	1.36 (0.80 – 2.31)	1.18 (0.71 – 1.96)	0.90 (0.42 – 1.94)	1.16 (1.03 – 1.31)*	1.60 (0.74 – 3.46)
0 minutes / week	554 (80)	1	1	1	1	1	1
1 – 99 minutes / week	106 (15)	1.52 (1.04 – 2.21)*	1.45 (0.81 – 2.60)	0.82 (0.44 – 1.53)	0.80 (0.33 – 1.97)	1.16 (1.01 – 1.32)*	1.92 (0.86 – 4.32)
≥ 100 minutes / week	37 (5)	1.25 (0.68– 2.33)	1.11 (0.41 – 3.01)	2.58 (1.20 – 5.55)*	1.22 (0.35 – 4.25)	1.18 (0.95– 1.48)	0.64 (0.08 – 4.95)
Sterilise medical instruments using automated systems							
Yes vs No	15 (2)	1.84 (0.77 – 4.40)	2.39 (0.72 – 7.91)	1.38 (0.38 – 5.01)	2.41 (0.51 – 11.43)	1.33 (0.97 – 1.83)	2.60 (0.53 – 12.77)
0 minutes / week	682 (98)	1	1	1	1	1	1
1 – 99 minutes / week	8 (1)	1.78 (0.53 – 6.02)	2.21 (0.42 – 11.50)	NC	2.76 (0.31 – 24.29)	1.18 (0.76 – 1.82)	2.54 (0.27 – 24.08)
≥ 100 minutes / week	7 (1)	1.90 (0.55 – 6.57)	2.62 (0.48 – 14.39)	4.29 (0.94 – 19.62)	2.13 (0.24 – 18.76)	1.53 (0.97 – 2.43)	2.66 (0.29 – 24.39)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: Geometric mean ratio (95% Confidence Interval); NC: not calculable

Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;

WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;

WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;

***: A combined variable consisting of 5 tasks involved in medical instruments cleaning and disinfection i.e. pre-cleaning of instruments by removing/flushing gross contaminants, diluting/mixing cleaning products, changing sterilization solutions, manually sterilize/disinfection of medical instruments and sterilize medical instruments using automated systems;

Table S5: Respiratory symptoms and airway inflammation associated with specific chemical agents and tasks used in fixed surface cleaning and disinfection in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [‡] (n = 654)	FeNO _{≥ 50} ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Fixed surfaces cleaning and disinfection Agents	572 (82)	1.40 (0.92 – 2.13)	1.56 (0.77 – 3.15)	0.83 (0.48 – 1.42)	0.90 (0.40 – 2.02)	1.12 (0.98 – 1.28)	1.05 (0.44 – 2.54)
Ammonia							
Yes vs No	73 (11)	0.96 (0.61 – 1.52)	1.06 (0.53 – 2.11)	0.87 (0.44 – 1.75)	0.15 (0.02 – 1.14)	1.00 (0.86 – 1.17)	1.30 (0.47 – 3.54)
0 minutes / week	624 (95)	1	1	1	1	1	1
1 – 99 minutes / week	24 (4)	1.60 (0.81 – 3.17)	2.76 (1.11 – 6.90)*	1.29 (0.47 – 3.58)	NC	1.12 (0.87 – 1.45)	0.65 (0.08 – 5.07)
≥ 100 minutes / week	9 (1)	0.34 (0.06 – 1.85)	NC	0.62 (0.08 – 5.20)	NC	0.97 (0.62 – 1.50)	3.17 (0.32 – 31.04)
Bleach							
Yes vs No	474 (68)	1.10 (0.80 – 1.52)	1.02 (0.62 – 1.69)	0.94 (0.60 – 1.47)	1.09 (0.56 – 2.14)	1.05 (0.95 – 1.17)	1.12 (0.54 – 2.34)
0 minutes / week	223 (40)	1	1	1	1	1	1
1 – 99 minutes / week	154 (27)	1.52 (1.04 – 2.22)*	1.52 (0.84 – 2.75)	0.77 (0.42 – 1.40)	0.66 (0.25 – 1.71)	1.14 (0.99 – 1.30)	1.48 (0.62 – 3.52)
≥ 100 minutes / week	189 (33)	0.95 (0.65 – 1.40)	0.89 (0.48 – 1.66)	1.35 (0.80 – 2.26)	1.58 (0.75 – 3.32)	1.03 (0.91 – 1.17)	1.32 (0.58 – 3.04)
Tasks							
Use more sprays vs more wipes	18 (3)	3.00 (1.50 – 5.98)**	5.58 (2.04 – 15.24)**	0.59 (0.13 – 2.66)	1.65 (0.35 – 7.81)	0.97 (0.72 – 1.30)	0.70 (0.09 – 5.63)
Spray deodorant/ disinfectant							
Yes vs No	208 (30)	1.46 (1.08 – 1.99)*	1.54 (0.95 – 2.47)	1.06 (0.67 – 1.68)	0.87 (0.44 – 1.70)	1.20 (1.08 – 1.33)**	1.76 (0.89 – 3.45)
0 minutes / week	489 (78)	1	1	1	1	1	1
1 – 99 minutes / week	128 (20)	1.76 (1.23 – 2.52)**	2.00 (1.17 – 3.44)*	1.24 (0.73 – 2.09)	0.88 (0.39 – 1.99)	1.23 (1.09 – 1.39)**	1.81 (0.82 – 3.98)
≥ 100 minutes / week	12 (2)	0.92 (0.29 – 2.89)	0.66 (0.08 – 5.45)	0.48 (0.06 – 3.76)	NC	1.05 (0.74 – 1.49)	1.70 (0.20 – 14.24)
Terminal cleaning of patient rooms							
Yes vs No	159 (23)	1.05 (0.74 – 1.47)	1.05 (0.62 – 1.79)	0.64 (0.37 – 1.11)	0.88 (0.42 – 1.83)	1.10 (0.98 – 1.24)	1.32 (0.61 – 2.84)
0 minutes / week	538 (87)	1	1	1	1	1	1
1 – 99 minutes / week	59 (10)	1.24 (0.76 – 2.04)	1.26 (0.59 – 2.69)	0.90 (0.42 – 1.92)	0.91 (0.31 – 2.70)	1.08 (0.90 – 1.28)	1.41 (0.46 – 4.29)
≥ 100 minutes / week	21 (3)	1.29 (0.58 – 2.88)	1.51 (0.47 – 4.87)	0.53 (0.12 – 2.34)	0.64 (0.08 – 4.94)	1.08 (0.82 – 1.42)	0.93 (0.12 – 7.41)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); NC: not calculable
Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;
WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;
WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work.

Table S6: Respiratory symptoms and airway inflammation associated with specific chemicals used in specimen preparation in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [*] (n = 654)	FeNO ≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Specimen preparation products	157 (23)	1.36 (0.98 – 1.90)	1.21 (0.72 – 2.04)	1.43 (0.89 – 2.29)	1.27 (0.65 – 2.48)	1.20 (1.07 – 1.35)**	1.25 (0.58 – 2.67)
Formalin 10% in normal saline							
Yes vs No	146 (21)	1.34 (0.96 – 1.88)	1.17 (0.68 – 1.99)	1.39 (0.86 – 2.24)	1.21 (0.61 – 2.42)	1.19 (1.06 – 1.34)**	1.15 (0.52 – 2.52)
0 minutes / week	549 (82)	1	1	1	1	1	1
1 – 99 minutes / week	110 (17)	1.55 (1.07 – 2.26)*	1.26 (0.70 – 2.27)	1.56 (0.93 – 2.64)	1.22 (0.56 – 2.64)	1.20 (1.05 – 1.38)**	1.32 (0.58 – 3.00)
≥ 100 minutes / week	5 (1)	0.67 (0.10 – 4.29)	NC	1.51 (0.17 – 13.77)	NC	1.18 (0.68 – 2.04)	NC
Alcohol-based cytological fixative spray							
Yes vs No	25 (4)	1.34 (0.66 – 2.73)	1.67 (0.63 – 4.43)	2.10 (0.84 – 5.24)	1.67 (0.47 – 5.92)	1.33 (1.04 – 1.71)*	2.27 (0.62 – 8.35)
0 minutes / week	672 (98)	1	1	1	1	1	1
1 – 99 minutes / week	17 (2)	1.56 (0.67 – 3.66)	1.28 (0.71 – 2.30)	2.30 (0.78 – 6.73)	1.67 (0.36 – 7.78)	1.55 (1.15 – 2.09)**	3.62 (0.93 – 14.17)
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC	NC	NC
Solvents							
Yes vs No	2 (0)	3.27 (0.41 – 25.87)	4.64 (0.28 – 77.99)	NC	NC	0.85 (0.36 – 2.02)	NC
0 minutes / week	695 (100)	1	1	1	1	1	1
1 – 99 minutes / week	2 (0)	3.27 (0.41 – 25.87)	4.64 (0.28 – 77.99)	NC	NC	0.85 (0.36 – 2.02)	NC
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC	NC	NC

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: Geometric mean ratio (95% Confidence Interval); NC: not calculable
Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;
WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work);
WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work).

Table S7: Respiratory symptoms and airway inflammation associated with specific chemical agents and tasks used for patients' skin/wound cleaning and disinfection in tertiary hospital health workers

	n (%)	Asthma symptoms score ^{##}	Asthma symptoms (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [*] (n = 654)	FeNO ≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Patients' skin/wound cleaning and disinfection	327 (47)	1.23 (0.92 – 1.64)	1.17 (0.74 – 1.85)	1.03 (0.68 – 1.57)	0.71 (0.39 – 1.31)	1.16 (1.06 – 1.28)**	1.55 (0.80 – 3.00)
Disinfect skin areas on patients prior to procedure							
Yes vs No	253 (36)	1.37 (1.02 – 1.83)*	1.46 (0.92 – 2.31)	1.53 (1.00 – 2.34)*	0.79 (0.42 – 1.50)	1.08 (0.98 – 1.19)	0.94 (0.47 – 1.86)
0 minutes / week	444 (74)	1	1	1	1	1	1
1 – 99 minutes / week	96 (16)	1.33 (0.87 – 2.02)	1.26 (0.65 – 2.45)	1.39 (0.76 – 2.54)	1.00 (0.42 – 2.39)	1.11 (0.96 – 1.28)	0.50 (0.15 – 1.70)
≥ 100 minutes / week	58 (10)	1.55 (0.94 – 2.57)	2.36 (1.15 – 4.81)*	2.30 (1.20 – 4.41)*	0.47 (0.11 – 2.03)	1.23 (1.03 – 1.47)*	1.95 (0.75 – 5.08)
Clean and disinfect wounds							
Yes vs No	162 (23)	1.17 (0.84 – 1.63)	1.19 (0.72 – 1.99)	1.02 (0.63 – 1.66)	1.03 (0.51 – 2.05)	1.14 (1.02 – 1.28)*	2.36 (1.19 – 4.68)*
0 minutes / week	535 (90)	1	1	1	1	1	1
1 – 99 minutes / week	39 (6)	0.98 (0.52 – 1.88)	0.88 (0.32 – 2.44)	0.31 (0.07 – 1.30)	0.36 (0.05 – 2.72)	1.15 (0.94 – 1.40)	0.59 (0.08 – 4.56)
≥ 100 minutes / week	22 (4)	1.81 (0.84 – 3.88)	3.21 (1.21 – 8.50)*	2.42 (0.95 – 6.15)	2.55 (0.80 – 8.08)	1.41 (1.09 – 1.82)**	7.36 (2.51 – 21.58)***
Apply wound dressing							
Yes vs No	143 (21)	1.19 (0.84 – 1.68)	1.10 (0.64 – 1.88)	1.29 (0.79 – 2.11)	1.08 (0.53 – 2.19)	1.04 (0.92 – 1.17)	0.91 (0.40 – 2.07)
0 minutes / week	554 (90)	1	1	1	1	1	1
1 – 99 minutes / week	44 (7)	1.14 (0.63 – 2.06)	0.85 (0.32 – 2.30)	0.76 (0.29 – 2.00)	0.63 (0.15 – 2.74)	1.22 (1.00 – 1.49)*	1.81 (0.58 – 5.61)
≥ 100 minutes / week	18 (3)	1.34 (0.57 – 3.15)	2.55 (0.88 – 7.37)	2.15 (0.74 – 6.26)	3.60 (1.08 – 11.94)*	0.99 (0.74 – 1.33)	NC
Use adhesives							
Yes vs No	279 (40)	1.36 (1.02 – 1.83)*	1.42 (0.90 – 2.25)	1.13 (0.74 – 1.73)	0.89 (0.48 – 1.65)	1.10 (1.00 – 1.21)	1.51 (0.79 – 2.91)
0 minutes / week	418 (69)	1	1	1	1	1	1
1 – 99 minutes / week	154 (26)	1.55 (1.10 – 2.18)*	1.44 (0.83 – 2.51)	1.17 (0.71 – 1.95)	0.53 (0.21 – 1.31)	1.16 (1.03 – 1.30)*	1.82 (0.86 – 3.81)
≥ 100 minutes / week	30 (5)	1.16 (0.59 – 2.30)	1.89 (0.72 – 5.02)	2.04 (0.86 – 4.83)	2.47 (0.86 – 7.09)	1.09 (0.87 – 1.38)	0.64 (0.08 – 4.99)
Use adhesive removing solvents							
Yes vs No	197 (28)	1.50 (1.10 – 2.04)*	1.43 (0.88 – 2.31)	0.91 (0.57 – 1.46)	0.62 (0.30 – 1.29)	1.15 (1.04 – 1.28)**	1.45 (0.72 – 2.91)
0 minutes / week	500 (81)	1	1	1	1	1	1
1 – 99 minutes / week	105 (17)	1.74 (1.19 – 2.54)**	1.38 (0.75 – 2.53)	0.88 (0.48 – 1.61)	0.23 (0.05 – 0.98)*	1.24 (1.09 – 1.42)**	2.03 (0.92 – 4.49)
≥ 100 minutes / week	14 (2)	1.63 (0.66 – 4.04)	3.47 (1.06 – 11.36)*	2.06 (0.62 – 6.84)	2.24 (0.45 – 11.11)	1.04 (0.75 – 1.459)	NC

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: Geometric mean ratio (95% Confidence Interval); NC: not calculable

Adjusted for atopy, gender and smoking; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;

WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;

WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work.

Table S8: Respiratory symptoms and airway inflammation associated with fixed surface cleaning and disinfection tasks in tertiary hospital health workers

	n (%)	Asthma symptom score ^{##}	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS	FeNO, ppb [†] (n = 654)	FeNO ≥ 50 ppb (n = 654)
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)		41 (6)
Fixed surfaces cleaning and disinfection Tasks	572 (82)	1.23 (0.80 – 1.90)	1.41 (0.68 – 2.91)	0.92 (0.53 – 1.60)	1.01 (0.44 – 2.32)	1.04 (0.92 – 1.19)	0.88 (0.35 – 2.20)
Spray deodorant/ disinfectant							
Yes vs No	208 (30)	1.24 (0.87 – 1.76)	1.38 (0.79 – 2.41)	1.44 (0.83 – 2.52)	1.15 (0.51 – 2.61)	1.10 (0.98 – 1.24)	1.51 (0.67 – 3.39)
0 minutes / week	489 (78)	1	1	1	1	1	1
1 – 99 minutes / week	128 (20)	1.48 (0.99 – 2.21)	1.71 (0.93 – 3.16)	1.61 (0.87 – 2.96)	1.08 (0.43 – 2.74)	1.14 (0.99 – 1.30)	1.62 (0.66 – 3.98)
≥ 100 minutes / week	12 (2)	0.69 (0.21 – 2.19)	0.56 (0.07 – 4.78)	0.62 (0.08 – 5.12)	NC	0.92 (0.65 – 1.31)	1.39 (0.16 – 12.39)
Terminal cleaning of patient rooms							
Yes vs No	159 (23)	0.83 (0.58 – 1.20)	0.87 (0.49 – 1.54)	0.74 (0.40 – 1.34)	1.13 (0.49 – 2.65)	0.99 (0.88 – 1.13)	1.05 (0.45 – 2.49)
0 minutes / week	538 (87)	1	1	1	1	1	1
1 – 99 minutes / week	59 (10)	1.00 (0.60 – 1.66)	1.00 (0.46 – 2.22)	1.01 (0.45 – 2.26)	1.20 (0.37 – 3.86)	0.97 (0.81 – 1.16)	1.14 (0.35 – 3.67)
≥ 100 minutes / week	21 (3)	1.12 (0.51 – 2.50)	1.27 (0.39 – 4.21)	0.56 (0.13 – 2.50)	0.73 (0.09 – 5.75)	1.04 (0.79 – 1.36)	0.84 (0.10 – 6.79)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; †: Geometric mean ratio (95% Confidence Interval); NC: not calculable
Adjusted for atopy, gender, smoking, age, study site and allergic sensitisation to natural rubber latex; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;
WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work;
WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work).