

Peaks, Means and Determinants of Real-Time TVOC Exposures Associated with Cleaning and Disinfecting Tasks in Healthcare Settings

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Supplementary File

Supplementary Methods

A user-friendly R-code demonstrated on a simulated example dataset, can be downloaded from either one of the links below:

1. <https://github.com/eahouseman/rtxm>
2. <https://www.cdc.gov/niosh/topics/drst/> under the NIOSH Resources section of: A Bayesian Approach for Modeling Real-Time Exposure Data with Left Censoring:

Portion of the R-code used to conduct these analyses is provided below:

R-Code

```
#####  
# Fit Multiple Regression model with 6 Covariates.  
  
# Fixed Effect = ProdUseNew5  
# zCovariates = ~factor(Ctrl_Local_exhaust_hood)+Distance2+RoomVolume2  
#           +ToolSpray_Wipe+ToolSterlz_Machn+Madge_MeanRH2  
#####  
  
#####  
##### Final multiple regression model with 6 Covariates #####  
  
source("rtxm.R") # Functions that will comprise the package  
  
myModel <- rtxmProfileREffLODsCovariatesModel(  
  ~lnYND,           # Response (Y)  
  ~ProdUseNew5,     # Task (factor variable)  
  theSplineBasis,   # Spline basis object (see above)  
  LOD=data$lnLOD,   # LODs (on same scale as Y)  
  
  zCovariates=~factor(Ctrl_Local_exhaust_hood)+Distance2+RoomVolume2+ToolSpray_Wipe+ToolSterlz_  
  Machn+Madge_MeanRH2,  
  data=data,        # Data set to interpret variables  
  gGroup=~SampleGroupID, # Series (profile) identifier  
  rng.seed=1        # Added Seed to get reproducible estimates  
)  
  
update(myModel,100) # Adaptation  
update(myModel,1000) # Burn-in  
myModel  
  
update(myModel,10000,"$standard",10) # 10000 samples thinned by 10  
myModel  
  
summary(myModel)           # Model summary
```

```

myPredictions <- predict(myModel) # Predictions

ModelResult<-summary(myModel) # Model summary
#str(ModelResult) #Check MdelResult structure or component

##### Added Quantile Estimation Below #####
# Extract chains for specific parameters
taskMean <- getTaskMeans(myModel) # Task-specific means

#### Variance components
epsilonSD <- getVarianceComponents(myModel, "epsilon") # Task specific
zetaSD <- getVarianceComponents(myModel, "zeta") # Time series

#Profile: Used for "REff" Models;
alphaSD <- getVarianceComponents(myModel, "precisionAlpha", precisionToSD=TRUE)

source("rtxmUtilQuantiles.R")

NSIMQUANT <- 1000 # Number of simulations per MCMC sample (should be at least 1000 in real life)
QUANTS <- c(0.01, seq(0.025, 0.975, 0.025), 0.99) # Various quantiles of interest

# Note: these need to match the original data set
HOURSAUTO <- 0.25 # Number of hours over which to calculate aggregate
MINUTESPERSAMP <- 5 # Original number of minutes per sample

# Spline representing consecutive measurements (for Quantiles), centered around 12pm
mySplineQuantiles <- makeProxySpline(HOURSAUTO*60,MINUTESPERSAMP,
                                     knotsDays=myModel@knots,knotsBoundary=myModel@boundary)

#Add statement set.seed(1) to get reproducible Quantiles.
set.seed(1)
resultsQuantile <- getQuantileSeries(NSIMQUANT, taskMean, zetaSD, epsilonSD,
                                     sp=mySplineQuantiles, sigmaA=alphaSD, quants=QUANTS,
                                     transform=exp) # Important: if original scale of data is log, distribution must be un-
logged

#Export Quantile Summary Outputs to CSV Files;
write.csv(apply(resultsQuantile[,,"75"], 2, summary),
          "Corrt2PPBAvg_ProdUseNew5_MultiRegr_6Covar_Qt75.csv")
write.csv(apply(resultsQuantile[,,"95"], 2, summary),
          "Corrt2PPBAvg_ProdUseNew5_MultiRegr_6Covar_Qt95.csv")

```

Supplementary Table S1: Characteristic of the real-time PID instruments

	ppbRae 2000	ToxiRae PGM-1800
Sampler Type	Mobile-area	Personal
Sampling Mode	Active	Passive
Detection	Photoionization	Photoionization
Lamp	10.6 eV	10.6 eV
Measurement Range	<0.1 to 20,000 ppb	<0.1 to 1,000 ppm
Limit of detection	1.0 ppb	0.1 ppm
Response Time (s)	<5	15 (Isobutene T ₉₀)
Averaging Time (s)	10	10
Interferences	CH ₃ (methane), C ₂ H ₆ (ethane), water vapor	CH ₃ (methane), C ₂ H ₆ (ethane), water vapor

PID=photoionization detector; TVOC=total volatile organic compound; ppb=parts per billion; ppm=parts per million; (s)=seconds

Supplementary Table S2: Posterior distributions of the cTVOC summary statistics for tasks showing: a) mean GM, b) median GM and 95%CI, c) median GSD and 95%CI, and d) median P95 and IQR

Variable Task	N	Mean GM (ppb)	Median GM (ppb) (95% CI)	Median GSD (95% CI)	Median P95 (ppb) (IQR)	
Main Fixed Effect of Tasks	No Product Use (Intercept)	7993	924	925 (759, 1121)	1.34 (1.32, 2.57)	8226 (7440, 9091)
	Alcohol Skin Wipe	232	855	854 (599, 1203)	1.96 (1.75, 3.59)	9595 (8493, 10940)
	Alcohol Surface Cleaning	38	986	990 (542, 1795)	1.83 (1.48, 3.25)	9504 (8032, 11360)
	Bleach Surface Cleaning	46	969	964 (691, 1403)	1.09 (1.05, 1.76)	7278 (6372, 8335)
	Chlorine Skin Wipe	39	1047	1063 (638, 1601)	1.27 (1.12, 2.29)	8479 (7033, 10070)
	Dental Products	9	1320	1223 (575, 3741)	1.5 (1.15, 3.85)	10980 (8580, 15610)
	Detergent Bathroom Cleaning	27	911	896 (474, 1782)	2.15 (1.59, 3.6)	9582 (7831, 11870)
	Detergent Instrument Cleaning	64	851	855 (530, 1393)	1.34 (1.22, 2.98)	7496 (6465, 8832)
	Detergent Skin Cleaning	3	694	682 (396, 1246)	1.04 (1.02, 1.15)	4843 (3745, 6285)
	Detergent Surface Cleaning	17	1049	990 (658, 2095)	1.14 (1.07, 2.98)	8513 (7453, 10140)
	EA/BA/GE Floor Stripping	206	898	902 (605, 1278)	1.63 (1.47, 5.42)	9761 (8168, 17780)
	EA/GE/ Glass Cleaning	62	1137	1046 (666, 2141)	1.21 (1.12, 2.47)	9185 (7763, 11050)
	EA/GE Surface Cleaning	51	741	970 (290, 1468)	1.29 (1.15, 3.21)	7703 (4621, 9352)
	Enzymatic Cleaning	149	1260	1080 (744, 2401)	1.2 (1.14, 2.27)	9852 (8254, 12630)
	Formaldehyde in Laboratory	26	398	387 (197, 875)	1.43 (1.23, 2.06)	3172 (2220, 4402)
	HLD on Instruments	40	1102	1094 (581, 2207)	2.14 (1.65, 4.17)	12180 (9865, 15710)
	Iodine Skin Wipe	36	717	701 (417, 1355)	1.63 (1.22, 4.09)	6946 (5697, 9275)
	Non Cleaning-Other Product	192	830	846 (558, 1185)	1.41 (1.28, 2.79)	7452 (6642, 8403)
	Non Cleaning-Dialysis Buffer	7	1098	1063 (563, 2419)	1.25 (1.09, 3.28)	8877 (7523, 10760)
	Non Cleaning-Lab Reagent	28	1204	1174 (641, 2345)	1.26 (1.14, 1.96)	9255 (7877, 10780)
	Non Cleaning-Medications	63	866	875 (524, 1345)	1.48 (1.23, 3.72)	8473 (7328, 10040)
	Phenolics Products	109	876	885 (582, 1251)	1.22 (1.16, 2.77)	7656 (6786, 8655)
	Quats Bathroom Cleaning	14	635	670 (253, 1227)	1.19 (1.1, 5.79)	6318 (5164, 7985)
Quats Floor Cleaning	346	960	955 (722, 1307)	1.14 (1.11, 1.62)	7180 (6301, 8150)	
Quats Skin Wipe	23	2112	2091 (943, 4766)	1.45 (1.22, 2.42)	17360 (13850, 22040)	
Quats Surface Cleaning	450	1005	984 (726, 1469)	1.45 (1.36, 2.93)	9337 (8196, 10920)	
Solvent Products	6	953	1024 (347, 2083)	1.27 (1.08, 5.23)	8924 (7338, 11080)	
SD	Spline (σ_i): Median (95%CI)			1.2 (0.03, 1.23)		
	Random (σ_α): Median (95%CI)			1.02 (0.91, 1.17)		

cTVOC=corrected TVOC concentrations; N= number of 5 minute measurements; GM=geometric mean; GSD=geometric standard deviation; CI=credible intervals; IQR=inter-quartile range; ppb=parts per billion; EA/BA/GE= ethanolamines/benzyl alcohols/glycol ethers; EA/GE=ethanolamines/glycol ethers; HLD=high-level disinfectants; Quats=quaternary ammonium compounds; SD=standard deviations; model parameters are exponentiated to get GM, GSD, P95.

Supplementary Table S3: Models summaries showing distributions of one time-invariant or time-varying covariate in models that included the main fixed effect of task

Time-Invariant Covariates	Mean (β) (% Change)	Median (β) (% Change)	95% CI (β)	Time-Varying Covariates	Mean (β) (% Change)	Median (β) (% Change)	95% CI (β)
Model task and one covariate (occupation)				Model task and one time varying covariate			
Clinical Lab Techs (Reference)				Air Changes per Hour			
Nursing Assistants	1.52 (355.6)	1.5 (347.4)	0.61, 2.24	≤ 10 (Reference)			
Dental Assistants	2.34 (940.1)	2.34 (942.1)	1.29, 3.3	> 10	0.08 (8.8)	0.08 (8.7)	0, 0.17
Dental Lab Techs	0.71 (103.5)	0.71 (102.6)	-0.1, 1.36	N/A	0.02 (2.1)	0.02 (2)	-0.06, 0.09
Endoscopy Techs	0.83 (129.7)	0.9 (146)	0.01, 1.44	General Ventilation			
Floor Strippers/Waxers	0.47 (60.7)	0.47 (60)	-0.29, 1.04	Absent (Reference)			
Housekeepers	1.39 (302.6)	1.42 (312.9)	0.9, 1.68	Present	0.04 (3.6)	0.03 (2.7)	-0.07, 0.19
Licensed Pract Nurses	2.27 (864.5)	2.25 (847.6)	1.4, 3.16	N/A	-0.01 (-0.6)	-0.01 (-0.5)	-0.06, 0.05
Med Equipment Preparers	0.85 (134.7)	0.92 (150.4)	-0.05, 1.42	Local Exhaust Hood			
Pharmacy Techs	1.41 (309.7)	1.39 (303.3)	0.62, 2.25	Absent (Reference)			
Registered Nurses	1.34 (281.5)	1.44 (321.8)	0.81, 1.64	Present	-0.11 (-10.7)	-0.15 (-14.1)	-0.35, 0.23
Respiratory Therapists	1.26 (252.6)	1.27 (256.8)	0.12, 2.3	N/A	0 (-0.5)	0 (-0.5)	-0.07, 0.05
Surgical Technologists	-0.09 (-8.5)	-0.13 (-12.2)	-1.32, 1.43	Automatic Sterilizer			
Model task and one covariate (hospital)				No (Reference)			
VA Hospital 1 (Reference)				Yes	-0.42 (-34.1)	-0.4 (-32.7)	-0.84, -0.06
VA Hospital 2	-0.95 (-61.4)	-0.86 (-57.5)	-1.59, -0.66	N/A	-0.2 (-18.2)	-0.19 (-17.4)	-0.42, -0.05
University Hospital 1	-0.04 (-3.5)	0.03 (3.2)	-0.81, 0.36	Tool Mop Use			
University Hospital 2	-0.46 (-37.1)	-0.47 (-37.7)	-0.92, -0.04	No mop use (Reference)			
Model task and one covariate (unit)				Regular mop			
Critical Care (Reference)				Micro fiber mop	-0.02 (-2)	-0.02 (-2.1)	-0.14, 0.1
Clinical Laboratory	-1.27 (-72)	-1.3 (-72.7)	-1.78, -0.55	N/A	0.05 (4.8)	-0.01 (-0.8)	-0.15, 0.35
Dental Clinic	0.32 (38.2)	0.23 (25.4)	-0.63, 1.29	Sampler Distance			
Dental Laboratory	-0.83 (-56.2)	-0.82 (-55.8)	-1.78, 0.02	≤ 3 feet (Reference)			
Dialysis	-1.39 (-75.1)	-1.46 (-76.8)	-2.01, -0.48	> 3 feet	-0.01 (-0.6)	-0.01 (-0.6)	-0.06, 0.04
Emergency Room	-0.1 (-9.6)	-0.11 (-10.8)	-0.77, 0.87	Product Amount			
Floor	-1.01 (-63.7)	-1.04 (-64.7)	-1.55, -0.22	Small (Reference)			
OR/GI	-0.26 (-23.2)	-0.29 (-25.5)	-0.57, 0.17	Large	-0.1 (-9.4)	-0.09 (-8.4)	-0.27, 0.01
Pharmacy	-0.23 (-20.5)	-0.19 (-17.5)	-1.02, 0.48	Non-Cleaning Product	-0.03 (-2.5)	-0.03 (-2.5)	-0.13, 0.09
Central Supply	-1.29 (-72.4)	-1.34 (-73.9)	-1.89, -0.4	N/A	-0.96 (-61.5)	-1.01 (-63.8)	-1.32, 0.03

Ward	-0.36 (-30)	-0.37 (-30.7)	-0.97, 0.18	Room Pressure			
Model task and one time-varying covariate				Positive (Reference)			
Tool Spray & Sponge				Negative	0 (-0.4)	-0.02 (-1.5)	-0.13, 0.14
No Tool Used (Reference)				N/A	-0.03 (-2.6)	-0.03 (-2.8)	-0.09, 0.04
Sponge only	0.01 (0.8)	0.02 (1.8)	-0.1, 0.09	Room Volume			
Spray only	0.19 (20.7)	0.16 (17.5)	-0.05, 0.57	Small (Reference)			
Sponge and Spray	0.06 (5.9)	0.06 (5.9)	-0.06, 0.19	Large	-0.11 (-10.6)	-0.11 (-10.4)	-0.22, -0.01
N/A	-0.05 (-4.7)	-0.01 (-0.7)	-0.27, 0.07	N/A	-0.1 (-9.9)	-0.1 (-9.8)	-0.2, -0.02
Humidity				Temperature			
% Relative Humidity	-0.01 (-1.1)	-0.01 (-1.1)	-0.02, -0.01	°Celsius	0.05 (5.6)	0.06 (6.5)	0.01, 0.08

cTVOC= corrected TVOC concentrations; N=number of 5-minute average measurements; β =posterior parameter for covariates; CI=credible intervals; %change= $(\exp(\beta)-1)*100\%$ for covariates; N/A=variable not relevant.

Supplementary Table S4: Posterior distributions of the GM, P95, and the GSD of cTVOC exposures in ppb for selected a) patient cleaning, b) surface cleaning and c) instrument cleaning task-occupation combinations

Task-Occupation	N	Mean GM	Median GM	GM 95% CI	Median GM Rank	Mean P95	Median P95	P95 IQR	Median P95 Rank	Median GSD Rank	Median GSD and 95% CI
Patient Cleaning											
AlcohSkinPrep_CNA	40	1698	1696	590, 4507	5	13220	12640	10310, 15460	6	22	1.13 (1.08, 2.33)
AlcohSkinPrep_ET/MEP	18	667	591	189, 4097	25	14720	8200	5797, 15340	18	3	2.93 (1.94, 6.96)
AlcohSkinPrep_PHT	15	748	728	185, 3039	21	13040	10190	6981, 15690	7	2	2.96 (1.97, 6.05)
AlcohSkinPrep_RN	137	964	951	362, 2249	18	8805	8577	7476, 9911	15	9	1.56 (1.41, 3.43)
AlcohSkinPrep_RT	10	2282	2323	524, 8932	1	54250	35510	22390, 57390	1	1	3.24 (2.19, 7.45)
ChlorSkinPrep_CNA	13	2222	2255	603, 6406	2	17900	17250	11730, 22250	2	16	1.3 (1.13, 1.93)
ChlorSkinPrep_RN	16	1258	1230	479, 3250	10	9438	9271	7572, 10950	10	26	1.09 (1.06, 2.17)
IodineSkinPrep_RN	36	794	786	319, 2013	20	7483	6933	5738, 8464	21	10	1.51 (1.22, 3.94)
QuatsSkinPrep_Nursing	25	2021	1971	730, 6195	3	16340	15470	12520, 19070	4	14	1.36 (1.19, 2.46)
Surface Cleaning											
AlcohSurfClnr_DLT	31	1196	1255	326, 2882	8	9452	9002	7010, 11480	12	19	1.2 (1.13, 2.2)
BleachSurfClnr_HK	33	1068	1037	494, 2880	15	7482	7332	6544, 8224	20	25	1.1 (1.04, 1.48)
BleachSurfClnr_RN	9	1072	1138	312, 2862	12	8268	8588	6027, 10450	14	30	1.05 (1.03, 1.83)
DetgtBathClnr_HK/FSW	30	973	956	380, 2757	17	9610	8924	7465, 11070	13	6	1.93 (1.51, 3.32)
DetgtSurfClnr_HK	17	1163	1122	513, 3433	13	9214	8497	7531, 9871	16	29	1.08 (1.05, 2.89)
EA_BA_GEFlrStrip_FSW	205	616	630	236, 1332	22	6948	6006	5030, 7999	23	8	1.62 (1.44, 5.21)
EA_GEGlassClnr_HK	58	1246	1164	528, 4026	11	9858	9100	7707, 11180	11	17	1.24 (1.14, 2.46)
EA_GESurfClnr_FSW	20	246	310	38, 792	30	2198	2331	1040, 2955	30	28	1.09 (1.06, 1.9)
EA_GESurfClnr_HK	31	1264	1284	543, 2610	7	9528	9538	7781, 11110	9	12	1.4 (1.25, 1.67)
QuatsBathClnr_HK	14	834	871	268, 1949	19	7814	6916	5888, 8319	22	21	1.16 (1.09, 4.54)
QuatsFlrClnr_HK/FSW	346	1102	1106	533, 2691	14	7874	7777	6940, 8689	19	23	1.13 (1.11, 1.6)
QuatsSurfClnr_DA	27	1943	1876	619, 7006	4	17890	16560	13140, 20740	3	7	1.78 (1.45, 2.62)
QuatsSurfClnr_ET/MEP	48	1389	1311	473, 5279	6	29660	13820	10330, 25440	5	5	2.02 (1.53, 8.62)
QuatsSurfClnr_HK/FSW	360	1030	1034	493, 2512	16	8460	8317	7392, 9331	17	11	1.45 (1.37, 2.58)
QuatsSurfClnr_RN	11	1363	1244	487, 5785	9	12300	9723	8044, 12880	8	18	1.23 (1.09, 3.44)
Instrument Cleaning											

DetgtInstClnr_ET/MEP	61	470	454	177, 1506	28	4070	3742	3053, 4579	28	15	1.35 (1.17, 3.02)
EnzymeClnr_ET	79	641	602	255, 2241	23	5308	4788	3924, 6018	25	19	1.22 (1.15, 2.68)
EnzymeClnr_MEP	68	646	587	233, 3069	26	4979	4475	3690, 5530	26	24	1.11 (1.08, 1.94)
HLD_Prod_ET	40	629	600	227, 2293	24	7190	6004	4783, 8166	24	4	2.04 (1.65, 3.96)
PhenoProd_ET	20	541	542	191, 1409	27	4302	4203	3471, 4997	27	13	1.38 (1.2, 2.33)
PhenoProd_MEP	32	315	324	99, 765	29	2535	2441	2039, 2907	29	27	1.09 (1.07, 2.91)

N= number of 5-minute average measurements; GM=geometric mean; ppb=parts per billion; P95=95th percentile; GSD=geometric standard deviation; CI=credible intervals; IQR=inter-quartile range; CNA=certified nursing assistant; ET=endoscopy technician; MEP=medical equipment preparer; PHT=pharmacy technician; RN=registered nurse; RT=respiratory therapist; DLT=dental laboratory technician; HK=housekeeper; FSW=floor stripper/waxer; DA=dental assistant

Supplementary Table S5: Distributions of the GM, P95, and the GSD of cTVOC concentrations for selected a) patient cleaning, b) surface cleaning and c) instrument cleaning task-unit combinations

Task-Unit	N	Mean GM	Median GM	GM 95% CI	Median GM Rank	Mean P95	Median P95	P95 IQR	Median P95 Rank	Median GSD Rank	Median GSD and 95% CI
Patient Cleaning											
AlcohSkinPrep_CC	28	935	919	472, 2177	27	10860	8101	6667, 11700	24	15	1.38 (1.16, 5.23)
AlcohSkinPrep_DIALYSIS	7	283	287	56, 1190	43	7438	2600	1882, 3769	40	16	1.38 (1.15, 8.31)
AlcohSkinPrep_FLOOR/WARD	30	1073	1080	381, 3137	17	14380	13250	10410, 17040	5	2	2.57 (1.91, 4.57)
AlcohSkinPrep_OR GI	135	1091	1065	546, 2445	20	10960	10610	9083, 12530	10	6	1.84 (1.59, 3.31)
AlcohSkinPrep_PHRAMACY	15	608	598	147, 2842	34	11870	8867	5770, 13810	16	1	3.05 (1.96, 6.08)
AlcohSkinPrep_SPD	11	744	720	258, 2657	32	8121	6943	4579, 9530	32	11	1.48 (1.13, 4.62)
ChlorSkinPrep_CC	13	1269	1264	594, 2953	11	9923	9715	7435, 12010	13	19	1.3 (1.13, 1.95)
ChlorSkinPrep_DIALYSIS	14	402	376	168, 1699	38	3228	2858	2236, 3659	38	32	1.12 (1.07, 2.14)
ChlorSkinPrep_OR GI	8	1113	1317	191, 3734	9	10540	10150	7529, 13080	11	28	1.14 (1.05, 4.15)
IodineSkinPrep_CC	8	772	772	158, 3977	31	18380	9380	6090, 17560	15	3	2.07 (1.3, 13.45)
IodineSkinPrep_ER	21	1144	1135	476, 2959	14	8748	8494	6856, 10370	20	25	1.2 (1.12, 1.8)
QuatsSkinPrep_WARD	23	2148	2119	852, 5898	2	18270	16940	13360, 22140	3	12	1.45 (1.23, 2.46)
Surface Cleaning											
AlcohSurfClnr_DENTAL LAB	31	961	1058	145, 3740	21	8623	8162	5067, 11210	23	24	1.21 (1.13, 2.26)
BleachSurfClnr_DIALYSIS	9	351	351	98, 1063	39	2759	2602	1949, 3375	39	38	1.07 (1.04, 1.85)
BleachSurfClnr_ER	28	1130	1110	520, 2679	15	8166	7839	6638, 9494	27	35	1.08 (1.04, 1.45)
BleachSurfClnr_WARD	7	1039	1079	377, 2787	18	7955	7981	5007, 10050	25	37	1.07 (1.03, 1.34)
DetgtBathClnr_DIALYSIS	6	324	311	115, 1337	42	2791	2372	1822, 3206	43	27	1.14 (1.06, 2.84)
DetgtBathClnr_WARD	14	1040	1053	468, 2530	22	7592	7375	6239, 8635	29	40	1.06 (1.04, 1.66)
DetgtSurfClnr_OR GI	12	1403	1290	608, 4633	10	11890	9991	8304, 13210	12	36	1.08 (1.05, 2.73)
EA_BA_GEFIrStrip_FLOOR	205	580	573	216, 1582	35	7290	6207	4523, 8715	34	10	1.63 (1.45, 5.24)
EA_GEGlassClnr_DIALYSIS	8	370	340	143, 2095	40	2827	2492	1914, 3229	41	42	1.04 (1.02, 1.24)
EA_GEGlassClnr_WARD	49	1360	1343	645, 3217	8	11600	11040	9226, 13550	9	14	1.4 (1.26, 2.72)
EA_GESurfClnr_FLOOR	20	243	312	34, 1099	41	2366	2380	709.9, 3360	42	34	1.1 (1.05, 1.89)
EA_GESurfClnr_WARD	31	1220	1255	477, 3151	12	9793	9649	6725, 12230	14	13	1.42 (1.26, 1.7)
PhenoProd_WARD	12	992	1014	418, 2552	25	7342	7123	5452, 8990	31	43	1.04 (1.03, 1.43)

QuatsBathClnr_WARD	12	772	834	188, 2276	30	8694	7247	5721, 9097	30	21	1.26 (1.14, 5.84)
QuatsFlrClnr_CC	65	1046	1032	632, 1962	24	7607	7511	6442, 8618	28	30	1.13 (1.08, 1.5)
QuatsFlrClnr_FLOOR/WARD	202	1088	1085	528, 2599	16	8169	7853	6430, 9445	26	31	1.12 (1.1, 1.7)
QuatsFlrClnr_OR GI	79	1172	1146	603, 2617	13	8569	8359	7227, 9740	21	26	1.16 (1.11, 1.55)
QuatsSurfClnr_CC	43	973	951	544, 2060	26	8732	8328	7171, 9814	22	9	1.7 (1.46, 2.64)
QuatsSurfClnr_DENTAL	27	2333	2158	887, 11360	1	23230	19590	15880, 25110	2	7	1.81 (1.47, 2.69)
QuatsSurfClnr_DIALYSIS	38	415	378	173, 2442	37	3364	2885	2128, 3775	37	39	1.06 (1.05, 1.74)
QuatsSurfClnr_ER	71	1038	1069	345, 2360	19	8767	8562	7103, 10150	19	18	1.3 (1.21, 2.74)
QuatsSurfClnr_FLOOR	9	702	717	239, 2105	33	5319	4892	3787, 6534	35	41	1.05 (1.03, 1.56)
QuatsSurfClnr_OR GI	100	1460	1411	741, 3498	4	11490	11080	9507, 12950	7	22	1.23 (1.18, 2.18)
QuatsSurfClnr_SPD	45	2056	2083	645, 7164	3	42080	27700	16830, 47870	1	5	1.99 (1.51, 9.17)
QuatsSurfClnr_WARD	117	905	896	422, 2218	28	9123	8795	7397, 10530	17	8	1.75 (1.53, 3.69)
Instrument Cleaning											
DetgtInstClnr_OR GI	57	1071	1043	510, 2630	23	9368	8732	7336, 10760	18	20	1.28 (1.2, 2.98)
EnzymeClnr_OR GI	81	1481	1403	742, 4014	5	12510	11260	9333, 14350	6	23	1.21 (1.15, 2.65)
EnzymeClnr_SPD	68	897	895	334, 3012	29	7282	6780	4885, 8773	33	29	1.13 (1.09, 1.98)
HLD_Prod_OR GI	40	1384	1360	603, 3781	6	16090	14400	11360, 18810	4	4	2.07 (1.66, 4.12)
PhenoProd_OR GI	62	1391	1357	692, 3218	7	11730	11060	9591, 13150	8	17	1.32 (1.2, 2.74)
PhenoProd_SPD	32	411	461	86, 1604	36	3815	3382	2214, 4983	36	33	1.11 (1.08, 2.9)

N= number of 5-minute average measurements; GM=geometric mean; ppb=parts per billion; P95=95th percentile; GSD=geometric standard deviation; CI=credible intervals; IQR=inter-quartile range; CC=Critical Care; OR GI=Operating room/gastroenterology; SPD= central supply; ER=Emergency Room

Supplementary Table S6: Proportions of the 14 quantified VOCs and their instrument response correction factors.

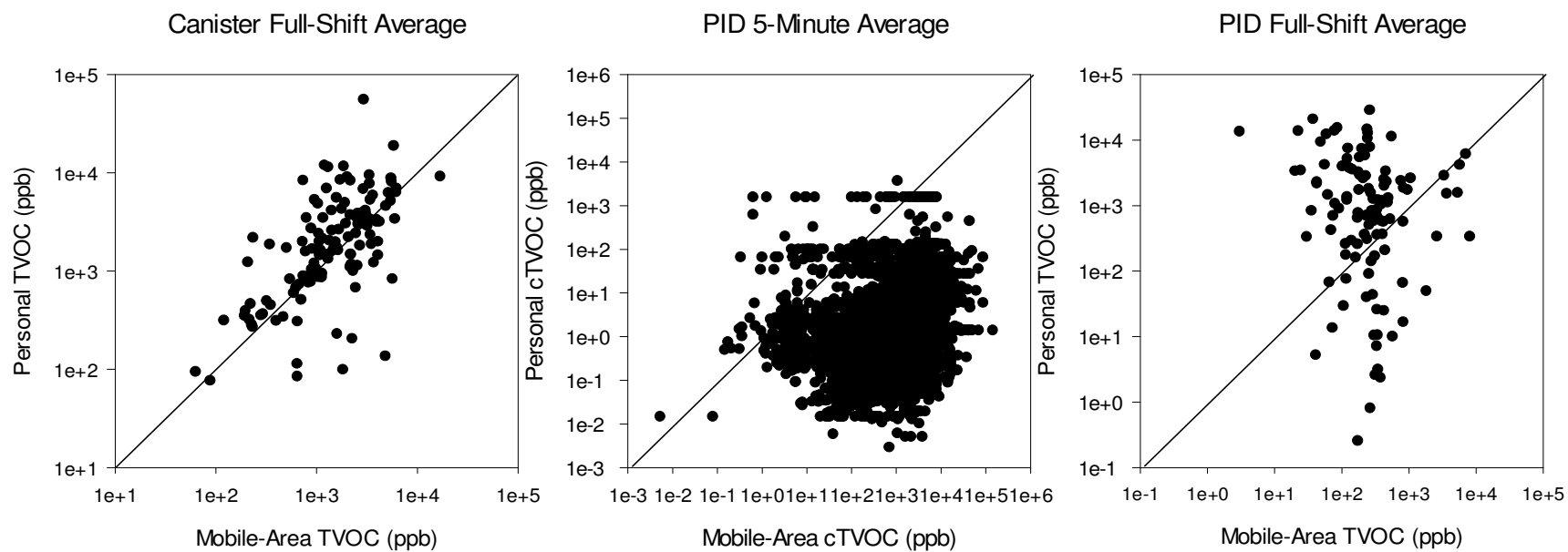
VOC	Proportion (range)	Correction Factor
Ethanol	0 - 0.97	9.6
Acetone	0.002 - 0.997	0.9
2-propanol	0 - 0.998	4.6
Methylene chloride	0 - 0.008	1 (default)
Hexane	0 - 0.009	4.3
Chloroform	0 - 0.002	1 (default)
Benzene	0 - 0.010	0.47
Methyl methacrylate	0 - 0.018	1.5
Toluene	0 - 0.037	0.45
Ethylbenzene	0 - 0.020	0.65
m,p-xylene	0 - 0.089	0.44/0.39
o-xylene	0 - 0.023	0.45
α -pinene	0 - 0.003	0.31
d-limonene	0 - 0.12	0.33

Default of 1 is used when the response correction factor is not provided by the manufacturer (Rae Systems Inc)

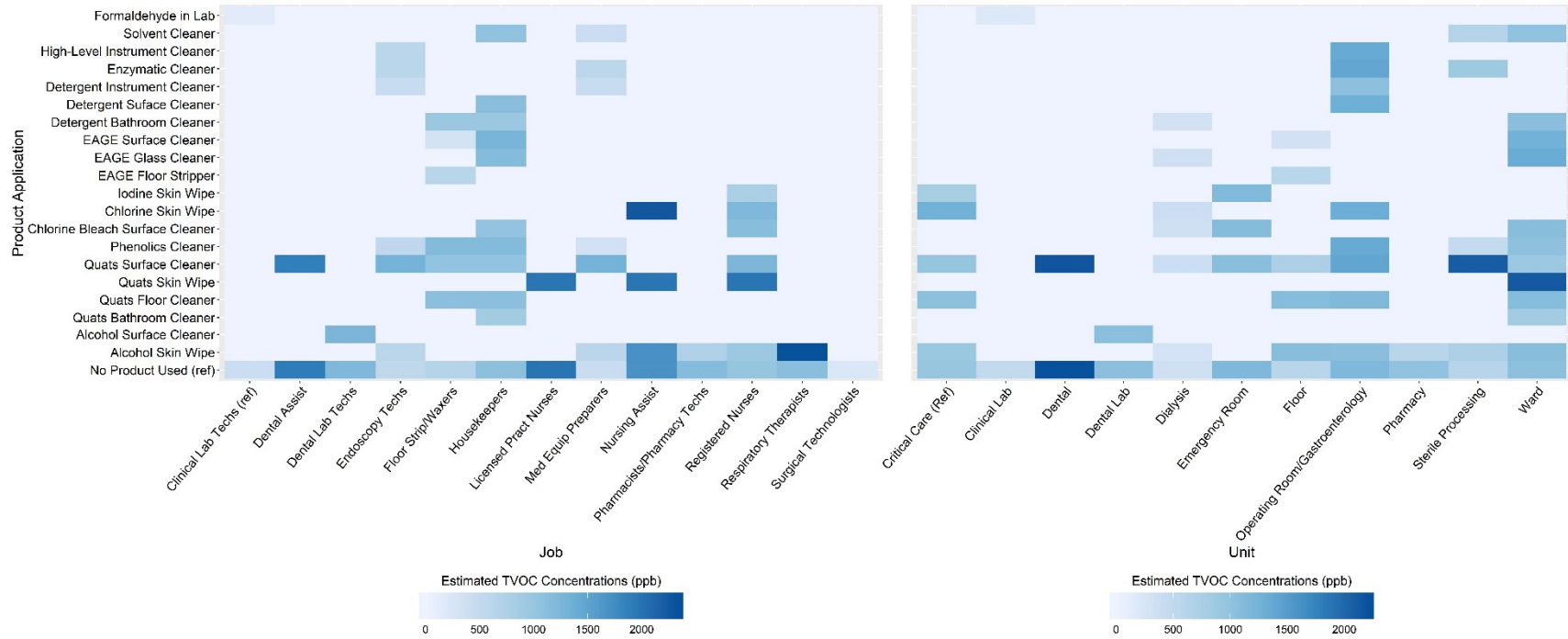
Supplementary Figure S1: Pictures of mobile-area and personal samplers used in the survey.



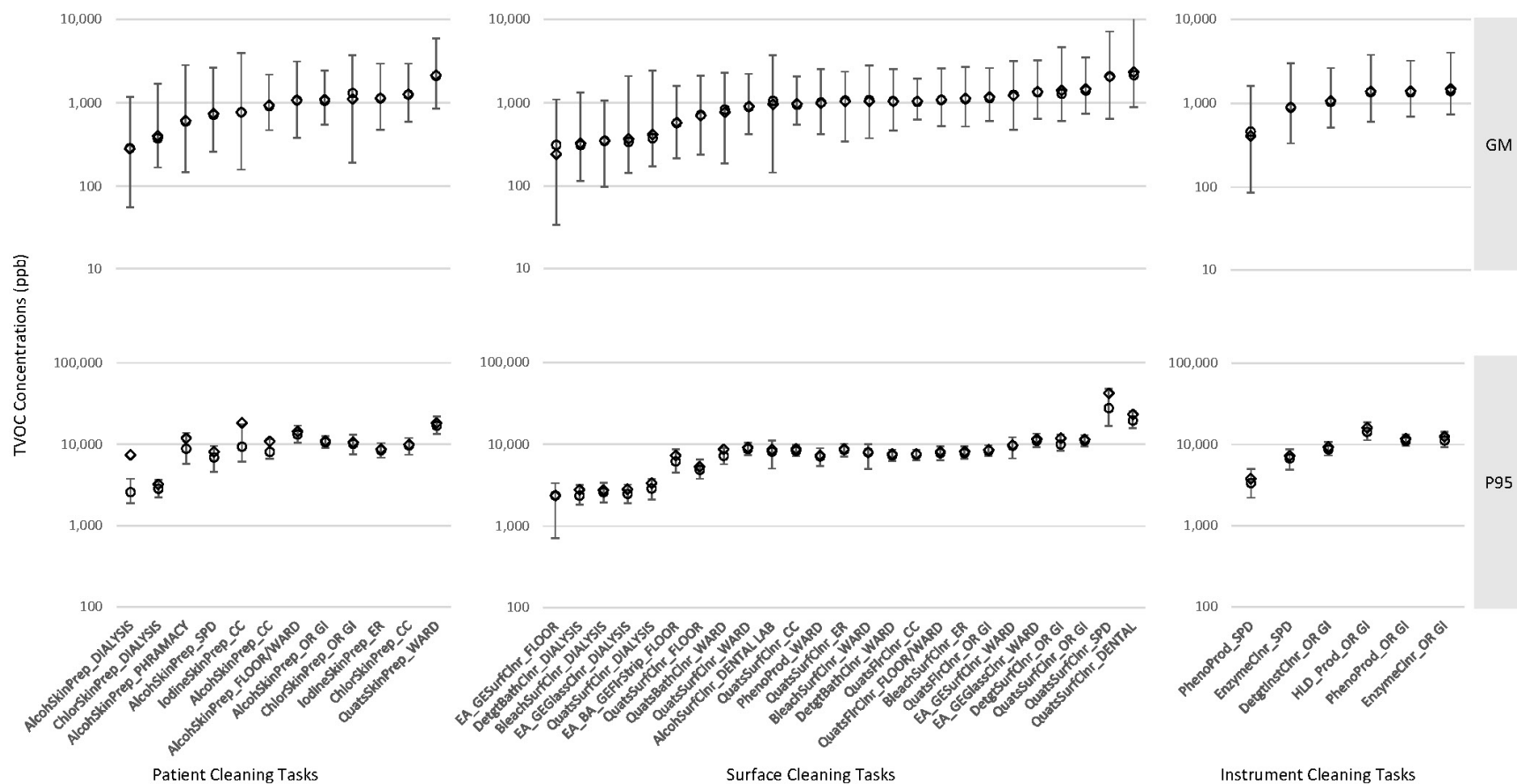
Supplementary Figure S2: Panel of 3 plots of correlation between personal and mobile-area TVOC measurements for a) time-integrated, full-shift canister measurements, b) real-time, five-minute average PID measurements, and c) time-integrated, full-shift PID measurements



Supplementary Figure S3: Heat map of the mean GM cTVOC concentration for selected tasks evaluating the effect of: a) occupations, and b) hospital units



Supplementary Figure S4: Distributions of the GM (top panels) and 95th percentiles (bottom panels) of cTVOC concentrations for selected a) patient cleaning (left panels), b) surface cleaning (center panels) and c) instrument cleaning (right panels) task-unit combinations;



Open diamond=mean; open circle=median; intervals around the GM are 95% Credible Intervals; intervals around the P95 are Inter Quartile Range (25-75%); model parameters are exponentiated to get GM and P95; CC=Critical Care; OR GI=Operating room/gastroenterology; SPD= central supply; ER=Emergency Room