

Table A1. Case Demographics

Case #	Type of Case*	Case Segments†	Anesthesia Provider Type	Surgical Procedure	Case Start Time	Case Duration (hr:min)	Patient ASA Status
1	NC	ST	CA3	Laparoscopic Ovarian Cystectomy & BTL	7:55	2:45	2
2	NC	T	CRNA	L Total Knee Arthroscopy	7:30	4:15	2
3	NC	ST	CRNA	R Knee Arthroscopic Partial Meniscectomy	9:15	3:00	3
4	NC	S	CRNA	L Arm AV Graft			
5	NC	S	CRNA	Total Thyroidectomy			
6	NC	T	CRNA	Total Thyroidectomy	7:40	5:05	3
7	NC	S	CRNA	Moh's Excision Posterior Neck			
8	NC	S	CRNA	L TRAM Flap Reconstruction			
9	NC	T	CRNA	Ileostomy Takedown	13:35	1:45	3
10	NC	T	CRNA	Laparoscopic R Inguinal Hernia Repair	12:15	2:05	3
11	NC	T	CRNA	Laparoscopic Ovarian Cystectomy & R Knee Arthroscopy	14:00	2:50	2
12	NC	T	CRNA	Anal Wart Removal	13:00	0:50	1
13	NC	T	CRNA	R Inguinal Hernia Repair	14:10	1:35	1
14	NC	T	CA1	Breast Scar Removal & Abdominal Hernia Repair	13:35	2:20	2
15	NC	T	CRNA	ORIF R Olecranon	13:00	3:20	1
16	NC	ST	CRNA	R Knee Arthroscopy	7:20	3:00	1
17	NC	T	CA3	Paraesophageal Hernia Repair, Nissen Fundoplication	14:00	6:10	2
18	NC	ST	CRNA	L Knee Arthroscopy	7:35	1:55	2
19	NC	T	CRNA	ORIF Ankle	13:40	2:15	1
20	NC	T	CRNA	Exploratory Laparotomy	13:10	1:35	3
21	C	T	CA3	Coronary Artery Bypass Grafting	7:35	3:25	3
22	C	T	CA2	Coronary Artery Bypass Grafting	7:45	3:10	3
23	C	ST	CA2	Coronary Artery Bypass Grafting	6:30	5:00	3
24	C	T	CA2	Coronary Artery Bypass Grafting	7:40	3:00	3
25	C	T	Faculty	Coronary Artery Bypass Grafting	6:50	2:30	3
26	NC	ST	CA2	Radical Retropubic Prostatectomy	7:10	3:30	2
27	C	ST	CA2	Coronary Artery Bypass Grafting	7:10	3:10	2
28	NC	T	CA3	R. Hemicolectomy, L. Hemicolectomy	7:35	4:45	2
29	NC	ST	CRNA	Laparoscopic Nissen Fundoplication	7:20	4:30	2
30	NC	T	CRNA	Resection of Right Neck Nodule	7:35	2:00	2
31	C	T	CA1	Coronary Artery Bypass Grafting	7:40	3:50	3

32	C	ST	CA1	Coronary Artery Bypass Grafting	7:25	2:45	2
33	C	S	CA3	Coronary Artery Bypass Grafting			
34	C	S	CA3	Coronary Artery Bypass Grafting			
35	C	S	CA1	Coronary Artery Bypass Grafting			

* C=Cardiac, NC=Non-Cardiac

‡ S=Set-up only, T=Total Case (no Set-up), ST=Set-up and Total Case.

Note: Case Duration includes break time taken by subjects that was excluded during data analysis.

Table A2. Initial Case Set-up: Percent Time of the Most Common Individual Tasks**Non-Cardiac Cases (N=10)**

Task Category*	Percent (Mean $\pm$ SD (Min-Max))		
Non-Drug/Fluid Task	53.59 $\pm$	16.51	(30.18- 80.70) [€]
Draw Drug/Fluid into Syringe	9.30 $\pm$	4.19	(2.20- 15.09)
Dispose of Sharps/Trash	5.91 $\pm$	5.18	(0.00- 16.28)
Prepare Vial for Medication Draw	5.91 $\pm$	4.69	(1.21- 16.81)
Manipulate/attach/remove terminal to/from syringe	4.18 $\pm$	3.82	(0.40- 11.28)
Place/Retrieve Syringe	4.18 $\pm$	2.36	(1.37- 7.79)
Open/Close Anesthesia Cart	3.96 $\pm$	2.63	(0.64- 8.54)
Assemble Syringe	2.99 $\pm$	2.37	(0.00- 6.49)
Other Drug Task	2.77 $\pm$	3.46	(0.00- 9.48)
Remove Wrapping	2.00 $\pm$	1.66	(0.00- 4.57)
Label Syringe	1.97 $\pm$	2.25	(0.00- 7.31)
Organize Workspace	1.94 $\pm$	3.23	(0.00- 10.57)
Add/Change IV Fluids	0.38 $\pm$	0.90	(0.00- 2.76) [€]
Manipulate IV tubing/stopcock, retrieve stopcock	0.27 $\pm$	0.58	(0.00- 1.58) [§]

Cardiac Cases (N=6)

Task Category*	Percent (Mean $\pm$ SD (Min-Max))		
Non-Drug/Fluid Task	24.80 $\pm$	16.35	(1.78- 40.21) [€]
Add/Change IV Fluids	14.49 $\pm$	9.71	(6.17- 33.03) [€]
Manipulate IV tubing/stopcock, retrieve stopcock	11.04 $\pm$	10.97	(3.95- 33.03) [§]
Dispose of Sharps/Trash	10.22 $\pm$	4.79	(4.13- 17.30)
Set-up IV	7.82 $\pm$	8.81	(0.73- 22.57)
Label Syringe	6.36 $\pm$	6.38	(0.00- 17.70)
Draw Drug/Fluid into Syringe	5.38 $\pm$	3.37	(0.00- 9.08)
Prepare Vial for Medication Draw	2.93 $\pm$	1.51	(0.00- 4.29)
Open/Close Anesthesia Cart	2.76 $\pm$	2.09	(0.00- 5.62)
Remove Wrapping	2.54 $\pm$	1.49	(0.00- 4.09)
Flush/squeeze/adjust IV	2.33 $\pm$	1.57	(0.00- 4.54)
Observe IV/Fluids	2.23 $\pm$	3.76	(0.00- 9.17)
Manipulate/attach/remove terminal to/from syringe	1.77 $\pm$	1.17	(0.00- 3.25)
Other Drug Task	1.60 $\pm$	1.89	(0.00- 4.66)
Place/Retrieve Syringe	1.46 $\pm$	0.86	(0.00- 2.21)
Assemble Syringe	1.37 $\pm$	1.22	(0.00- 3.30)
Manipulate IV Pole	0.71 $\pm$	1.02	(0.00- 2.51)

[‡] See Table 1 in published paper for grouped task categorization.

* Includes only tasks that comprised at least 0.33% of set-up period.

[€] Significant difference cardiac vs. non-cardiac cases; $p < 0.001$.

[§] Significant difference cardiac vs. non-cardiac cases; $p < 0.01$.

Table A3. Total Case: Percent Time of Individual Drug/Fluid-Related Tasks[‡]

Task Category*	Non-Cardiac[§]	Cardiac[†]
Charting drugs/fluids given	13.70 ± 9.69 (0.00-39.37)	17.40 ± 11.01 (3.62-37.58)
Adjust IV (flow rate)	8.88 ± 4.84 (0.72-21.01)	7.02 ± 1.80 (4.60- 9.16)
Withdraw drug from vial/ampoule	5.93 ± 2.17 (2.36-10.33)	2.38 ± 1.04 (1.00- 3.89)
Inject syringe	4.84 ± 2.14 (1.74- 9.32)	6.50 ± 1.98 (4.02- 9.78)
Open/close anesthesia cart drawer	4.41 ± 1.75 (1.47- 9.30)	1.53 ± 1.31 (0.42- 3.54)
Retrieve syringe	4.10 ± 1.77 (2.03- 9.57)	2.21 ± 0.87 (1.19- 3.59)
Place syringe	4.10 ± 1.71 (2.03 -7.83)	1.89 ± 1.00 (0.91- 3.73)
Manipulate IV tubing/stopcock	3.73 ± 2.58 (0.36- 9.10)	9.64 ± 3.72 (5.36-16.80)
Other Drug Task	3.54 ± 4.04 (0.00-13.69)	6.86 ± 5.90 (0.54-17.85)
Label syringe	3.48 ± 1.63 (0.33- 7.21)	4.76 ± 5.07 (0.86-16.57)
Dispose of wrapping	2.95 ± 1.41 (0.94- 6.58)	2.05 ± 0.77 (1.08- 3.45)
Hang/unhang IV fluids	2.91 ± 1.88 (0.70- 6.18)	2.32 ± 1.13 (0.69- 3.89)
Retrieve drug vial/ampoule	2.79 ± 1.23 (0.35- 4.99)	0.74 ± 0.35 (0.23- 1.16)
Inspect syringe	2.50 ± 1.67 (0.00- 5.88)	1.70 ± 0.83 (0.46- 3.02)
Remove wrapping	2.39 ± 1.74 (0.93- 8.20)	1.36 ± 0.15 (1.15- 1.61)
Turn/manipulate stopcock	2.35 ± 2.52 (0.20-11.06)	1.70 ± 0.87 (0.68- 3.00)
Flush/squeeze IV	2.34 ± 2.40 (0.00- 7.15)	1.98 ± 2.21 (0.00- 6.78)
Organize workspace (drug-related)	2.19 ± 2.10 (0.19- 8.64)	0.77 ± 0.48 (0.15- 1.45)
Remove syringe (stopcock/IV port)	1.93 ± 0.91 (0.49- 3.49)	1.24 ± 0.76 (0.60- 3.00)
Remove needle or cap	1.86 ± 1.12 (0.68- 5.12)	0.51 ± 0.41 (0.11- 1.27)
Manipulate IV pole	1.73 ± 1.63 (0.09- 6.64)	0.98 ± 0.76 (0.00- 2.30)
Observe IV and fluids	1.34 ± 1.27 (0.00- 4.58)	3.26 ± 2.18 (0.99- 7.78)
Attach needle to syringe	1.27 ± 0.94 (0.19- 4.42)	0.43 ± 0.38 (0.00- 0.97)
Attach syringe to stopcock	1.23 ± 0.74 (0.20- 3.61)	1.13 ± 0.47 (0.47- 1.69)
Recap needle	1.18 ± 0.99 (0.00- 3.79)	0.13 ± 0.17 (0.00- 0.50)
Open vial/ampoule	1.13 ± 1.14 (0.19- 5.14)	0.36 ± 0.24 (0.08- 0.84)
Place drug vial/ampoule	1.02 ± 1.06 (0.00- 3.87)	0.15 ± 0.19 (0.00- 0.49)
Dispose of vial/ampoule	1.01 ± 0.93 (0.00- 3.31)	0.38 ± 0.27 (0.00- 0.75)
Dispose of syringe	0.98 ± 1.39 (0.00- 6.27)	0.35 ± 0.26 (0.00- 0.69)
Retrieve syringe from drawer	0.88 ± 0.65 (0.15 -2.73)	0.39 ± 0.20 (0.11- 0.66)
Dispose of unknown item	0.63 ± 0.73 (0.00- 2.56)	0.37 ± 0.52 (0.04- 1.62)
Retrieve needle	0.63 ± 0.39 (0.08- 1.29)	0.15 ± 0.10 (0.00- 0.30)
Place needleless cap on syringe	0.60 ± 0.61 (0.00- 2.25)	0.28 ± 0.49 (0.00- 1.42)
Attach/remove fluids to tubing	0.56 ± 0.76 (0.00- 2.50)	2.77 ± 1.44 (0.62- 4.35)
Retrieve IV fluids	0.46 ± 0.75 (0.00- 2.42)	0.39 ± 0.26 (0.07- 0.80)
Insert syringe & needle into IV port	0.42 ± 0.84 (0.00- 2.71)	0.03 ± 0.07 (0.00- 0.19)
Adjust syringe pump	0.40 ± 1.09 (0.00- 4.30)	0.04 ± 0.08 (0.00- 0.23)
Inspect drug vial/ampoule	0.36 ± 0.57 (0.00- 1.96)	0.12 ± 0.16 (0.00- 0.46)
Remove cover from needle	0.35 ± 0.43 (0.00- 1.26)	0.06 ± 0.11 (0.00- 0.27)
Dispose of IV materials	0.25 ± 0.39 (0.00- 1.47)	0.86 ± 0.68 (0.24- 2.00)
Withdraw fluid/drug from IV bag	0.11 ± 0.30 (0.00- 1.13)	0.37 ± 0.41 (0.00- 0.92)
Attach tubing end or needle to IV line	0.09 ± 0.40 (0.00- 1.80)	0.51 ± 0.70 (0.00- 1.99)
Retrieve IV tubing	0.07 ± 0.19 (0.00- 0.63)	0.73 ± 0.86 (0.00- 2.55)
Insert tubing into infusion pump	0.03 ± 0.15 (0.00- 0.68)	0.66 ± 0.70 (0.00- 1.68)

Program infusion pump	0.00 ± 0.00 (0.00- 0.00)	9.76 ± 6.20 (0.00-16.57)
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- ‡ Excludes case set-up
- * Includes only tasks that comprised at least 0.33% of total case for either non-cardiac or cardiac cases.
- § Mean ± Std Dev (Min-Max) Percent, N=20
- † Mean ± Std Dev (Min-Max) Percent, N=8

**Table A4. Number of Incidences of the Most Common Individual Tasks
(Total Case data)[‡]****Non-Cardiac Cases (N=20)**

Task Category*	Number of Task Occurrences (Mean ± SD (Min-Max))		
Non-Drug/Fluid Task	61 ±	18	(27-94)
Open/close anesthesia cart drawer	22 ±	12	(11-62)
Adjust IV (flow rate)	19 ±	10	(2-40)
Retrieve syringe	18 ±	8	(9-41)
Place syringe	18 ±	8	(7-38)
Turn/manipulate stopcock	15 ±	8	(2-28)
Remove wrapping	13 ±	6	(5-23)
Dispose of wrapping	13 ±	8	(3-31)
Inject syringe	12 ±	3	(8-19)
Retrieve drug vial/ampoule	10 ±	5	(2-22)

Cardiac Cases (N=8)

Task Category*	Number of Task Occurrences (Mean ± SD (Min-Max))		
Non-Drug/Fluid Task	81 ±	16	(65 -105)
Adjust IV (flow rate)	25 ±	11	(11 -47)
Retrieve syringe	24 ±	9	(15 -40)
Turn/manipulate stopcock	23 ±	5	(13 -28)
Inject syringe	20 ±	4	(13 -25)
Attach syringe to stopcock	19 ±	5	(11 -25)
Manipulate IV tubing/stopcock	18 ±	8	(9 -31)
Program infusion pump	18 ±	17	(0 -45)
Place syringe	17 ±	9	(9 -37)
Observe IV and fluids	17 ±	11	(8 -44)

[‡] Excludes case set-up

* Data for the ten most common tasks by number of incidents.

**Table A5. Task Duration for the Most Common Individual Tasks
(Total Case data)[‡]****Non-cardiac Cases (N=20)**

Task Category*	Seconds/Task Occurrence (Mean±SD (Min-Max))			
Non-Drug/Fluid Task	135.85	± 41.36	(75.52 - 222.70)	§
Charting drugs/fluids given	25.91	± 20.02	(0.00 - 70.17)	§
Adjust IV (flow rate)	6.22	± 1.33	(4.13 - 9.33)	
Withdraw drug from vial/ampoule	9.67	± 4.41	(5.14 - 24.00)	
Inject syringe	5.30	± 1.84	(2.67 - 9.22)	
Open/close anesthesia cart drawer	2.75	± 0.60	(1.64 - 3.91)	
Retrieve syringe	3.07	± 1.30	(1.80 - 8.11)	
Place syringe	3.00	± 0.65	(2.24 - 4.71)	
Manipulate IV tubing/stopcock	7.81	± 3.80	(2.00 - 14.00)	
Other Drug Task	13.33	± 14.40	(0.00 - 54.00)	
Label syringe	10.88	± 5.14	(3.75 - 22.33)	§
Program infusion pump	0.00	± 0.00	(0.00 - 0.00)	§

Cardiac Cases (N=8)

Task Category*	Seconds/Task Occurrence (Mean±SD (Min-Max))			
Non-Drug/Fluid Task	90.95	± 12.75	(72.26 - 110.69)	§
Charting drugs/fluids given	32.39	± 12.82	(15.14 - 46.50)	§
Adjust IV (flow rate)	7.80	± 1.43	(5.70 - 9.91)	
Withdraw drug from vial/ampoule	10.97	± 4.46	(6.50 - 18.89)	
Inject syringe	8.43	± 1.63	(6.68 - 11.29)	
Manipulate IV tubing/stopcock	15.20	± 4.26	(11.00 - 24.22)	
Other Drug Task	22.47	± 14.57	(3.50 - 48.67)	
Label syringe	22.26	± 11.56	(9.86 - 42.57)	§
Observe IV and fluids	5.06	± 1.62	(2.63 - 7.21)	
Attach/remove fluids to tubing	11.56	± 5.04	(4.00 - 19.33)	
Program infusion pump	20.21	± 19.05	(0.00 - 64.00)	§

[‡] Excludes case set-up

* Data for the ten most common individual tasks performed during the total case (see Table A3). Tasks are listed in descending order based on non-cardiac case occurrence. Mean duration of non-drug/fluid task occurrences also provided for comparison.

§ Significant difference cardiac vs. non-cardiac cases; p<0.01

Table A6. Induction: Percent Time of All Grouped Drug/Fluid-Related Task Categories ‡**Non-Cardiac Cases (N=20)**

Task Category*	<u>Percent</u> (Mean±SD (Min-Max))		<u>Minutes</u> (Mean±SD (Min-Max))	
Deliver Drug via IV	22.36 ± 9.84	(7.84 - 40.63) [§]	1.26 ± 0.42	(0.40 - 2.17) [§]
Flush/squeeze/adjust IV	13.79 ± 8.78	(0.00 - 31.43) [†]	0.89 ± 0.65	(0.00 - 2.12)
Place/Retrieve Syringe	13.65 ± 4.75	(6.51 - 24.66) [€]	0.89 ± 0.58	(0.33 - 2.73)
Manipulate IV Tubing/stopcock, Retrieve Stopcock	8.84 ± 7.86	(0.00 - 28.17) [€]	0.51 ± 0.46	(0.00 - 1.58) [€]
Add/Change IV Fluids	6.46 ± 5.08	(0.00 - 18.95)	0.44 ± 0.40	(0.00 - 1.25) [§]
Dispose of Sharps/Trash	4.69 ± 4.80	(0.00 - 21.90)	0.33 ± 0.36	(0.00 - 1.27)
Charting Drugs/Fluids Given	4.49 ± 8.24	(0.00 - 25.86)	0.25 ± 0.47	(0.00 - 1.67)
Draw Drug/Fluid into Syringe	4.04 ± 4.94	(0.00 - 16.81)	0.34 ± 0.49	(0.00 - 1.68)
Manipulate IV Pole	3.91 ± 3.15	(0.00 - 10.36)	0.21 ± 0.19	(0.00 - 0.75)
Manipulate/attach/remove Terminal to/from Syringe	3.84 ± 1.85	(0.89 - 7.31)	0.24 ± 0.15	(0.05 - 0.62)
Open/Close Anesthesia Cart	3.00 ± 2.83	(0.00 - 11.42)	0.22 ± 0.23	(0.00 - 0.88)
Prepare Vial for Medication	2.21 ± 3.01	(0.00 - 10.13)	0.19 ± 0.34	(0.00 - 1.42)
Observe IV/Fluids	1.74 ± 1.80	(0.00 - 5.41)	0.10 ± 0.11	(0.00 - 0.30) [§]
Remove Wrapping	1.44 ± 2.41	(0.00 - 9.54)	0.12 ± 0.19	(0.00 - 0.73)
Assemble Syringe	1.35 ± 1.99	(0.00 - 7.16)	0.11 ± 0.17	(0.00 - 0.55)
Organize Workspace	1.19 ± 1.97	(0.00 - 6.95)	0.07 ± 0.10	(0.00 - 0.33)
Other Drug Task	1.03 ± 2.56	(0.00 - 11.06)	0.09 ± 0.21	(0.00 - 0.85) [§]
Syringe Pump Related Tasks	0.81 ± 2.50	(0.00 - 8.59)	0.10 ± 0.34	(0.00 - 1.42)
Label Syringe	0.62 ± 1.68	(0.00 - 6.68)	0.06 ± 0.18	(0.00 - 0.63)
Set-up Infusion Pump	0.00 ± 0.00	(0.00 - 0.00)	0.00 ± 0.00	(0.00 - 0.00) [§]

Cardiac Cases (N=8)

Task Category*	<u>Percent</u> (Mean±SD (Min-Max))		<u>Minutes</u> (Mean±SD (Min-Max))	
Manipulate IV Tubing/stopcock, Retrieve Stopcock	21.41 ± 6.06	(14.18- 32.54) [€]	3.18 ± 1.23	(1.78 - 4.82) [€]
Deliver Drug via IV	15.79 ± 4.24	(11.14- 21.51) [§]	2.35 ± 1.01	(1.28 - 4.62) [§]
Add/Change IV Fluids	9.79 ± 7.21	(0.25- 19.43)	1.52 ± 1.20	(0.03 - 3.30) [§]
Flush/squeeze/adjust IV	8.48 ± 3.69	(2.80- 12.59) [†]	1.23 ± 0.64	(0.62 - 2.37)
Other Drug Task	6.90 ± 9.90	(0.00- 28.66)	1.02 ± 1.44	(0.00 - 3.98) [§]
Place/Retrieve Syringe	5.91 ± 1.09	(4.40- 7.35) [€]	0.86 ± 0.21	(0.52 - 1.20)
Set-up Infusion Pump	4.90 ± 6.59	(0.00- 16.31)	0.84 ± 1.17	(0.00 - 3.02) [§]
Dispose of Sharps/Trash	4.52 ± 1.87	(1.08- 6.82)	0.68 ± 0.40	(0.15 - 1.50)
Draw Drug/Fluid into Syringe	3.94 ± 2.24	(0.72- 7.55)	0.56 ± 0.30	(0.10 - 1.00)
Observe IV/Fluids	3.80 ± 2.30	(1.20- 8.59)	0.55 ± 0.33	(0.17 - 1.15) [§]
Charting Drugs/Fluids Given	2.46 ± 2.83	(0.00- 6.24)	0.32 ± 0.37	(0.00 - 0.87)
Manipulate IV Pole	2.38 ± 1.59	(0.00- 4.68)	0.31 ± 0.20	(0.00 - 0.65)

Syringe Pump Related Tasks	2.12 ± 2.98	(0.00- 7.45)	0.27 ± 0.39	(0.00 - 1.03)
Prepare Vial for Medication	1.66 ± 1.50	(0.00- 4.09)	0.25 ± 0.23	(0.00 - 0.62)
Label Syringe	1.31 ± 2.14	(0.00- 5.68)	0.23 ± 0.44	(0.00 - 1.25)
Remove Wrapping	1.23 ± 0.95	(0.16- 2.58)	0.18 ± 0.18	(0.03 - 0.57)
Open/Close Anesthesia Cart	1.07 ± 1.18	(0.28- 3.86)	0.16 ± 0.16	(0.03 - 0.52)
Manipulate/attach/remove Terminal to/from Syringe	0.87 ± 0.54	(0.25- 1.73)	0.12 ± 0.07	(0.03 - 0.22)
Organize Workspace	0.67 ± 0.95	(0.00- 2.52)	0.09 ± 0.13	(0.00 - 0.35)
Assemble Syringe	0.58 ± 0.53	(0.08- 1.54)	0.08 ± 0.07	(0.02 - 0.18)

‡ See Table 1 in published paper for grouped task categorization.

* Includes only tasks that comprised at least 0.33% of induction period.

^e Significant difference cardiac vs. non-cardiac cases; p<0.001

[§] Significant difference cardiac vs. non-cardiac cases; p<0.01

[†] Significant difference cardiac vs. non-cardiac cases; p<0.05

Table A7. Maintenance: Percent Time of All Grouped Drug/Fluid-Related Task Categories ‡**Non-Cardiac Cases (N=20)**

Task Category*	Percent (Mean ± SD (Min-Max))			Minutes (Mean ± SD (Min-Max))		
Charting Drugs/Fluids Given	18.49 ±	14.78	(0.00 - 49.74) [§]	3.18 ±	3.51	(0.00 -15.17) [€]
Draw Drug/Fluid into Syringe	10.55 ±	4.23	(4.71 - 17.75)	1.49 ±	0.81	(0.43 -3.17)
Flush/squeeze/adjust IV	10.15 ±	6.78	(0.00 - 24.22)	1.48 ±	1.34	(0.00 -5.83) [§]
Dispose of Sharps/Trash	7.41 ±	3.50	(3.61 - 18.03)	1.04 ±	0.53	(0.43 -2.20)
Prepare Vial for Medication Draw	6.98 ±	3.19	(2.13 - 13.20)	1.04 ±	0.61	(0.17 -2.35)
Deliver Drug via IV	6.49 ±	3.72	(1.03 - 18.42)	0.91 ±	0.58	(0.17 -2.10) [§]
Place/Retrieve Syringe	5.88 ±	2.73	(1.09 - 10.46)	0.84 ±	0.42	(0.05 -1.47)
Open/Close Anesthesia Cart	4.87 ±	1.62	(0.39 - 7.89)	0.71 ±	0.40	(0.27 -1.55)
Manipulate/attach/remove Terminal	4.76 ±	3.01	(0.60 - 12.05)	0.64 ±	0.42	(0.10 -1.52)
Label Syringe	4.69 ±	2.65	(0.00 - 24.07)	0.72 ±	0.53	(0.00 -1.88) [§]
Other Drug Task	4.53 ±	6.07	(0.00 - 17.71)	1.97 ±	2.01	(0.00 -3.38)
Assemble Syringe	3.34 ±	2.61	(0.91 - 10.86)	0.44 ±	0.34	(0.12 -1.62)
Organize Workspace	2.83 ±	2.86	(0.00 - 11.43)	0.42 ±	0.51	(0.00 -2.18)
Remove Wrapping	2.56 ±	1.42	(0.81 - 5.49)	0.34 ±	0.18	(0.13 -0.82)
Add/Change IV Fluids	2.00 ±	3.71	(0.00 - 14.86)	0.31 ±	0.56	(0.00 -2.30)
Syringe Pump Related Tasks	1.39 ±	3.17	(0.00 - 9.12)	0.25 ±	0.54	(0.00 -1.48)
Observe IV/Fluids	1.18 ±	1.43	(0.00 - 6.48)	0.21 ±	0.34	(0.00 -1.47)
Manipulate IV tubing/stopcock, retrieve stopcock	0.78 ±	1.16	(0.00 - 4.23)	0.13 ±	0.21	(0.00 -0.75)
Manipulate IV Pole	0.61 ±	1.39	(0.00 - 5.96)	0.07 ±	0.14	(0.00 -0.47)
Set-up Infusion Pump	0.07 ±	0.29	(0.00 - 18.96) [€]	0.01 ±	0.04	(0.00 -9.75) [€]

Cardiac Cases (N=8)

Task Category*	Percent (Mean ± SD (Min-Max))			Minutes (Mean ± SD (Min-Max))		
Charting Drugs/Fluids Given	24.30 ±	14.40	(3.16 - 24.72) [†]	8.15 ±	6.09	(0.78 -18.52) [€]
Set-up Infusion Pump	12.72 ±	7.51	(0.00 - 24.43) [€]	4.29 ±	3.68	(0.00 -9.78) [€]
Flush/squeeze/adjust IV	9.64 ±	5.36	(3.59 - 19.03)	2.88 ±	2.01	(1.10 -6.02) [§]
Deliver Drug via IV	8.62 ±	4.75	(3.41 - 10.98)	2.24 ±	0.76	(0.97 -3.33) [§]
Other Drug Task	6.26 ±	6.09	(0.00 - 16.87)	1.97 ±	2.01	(0.00 -6.05)
Label Syringe	6.07 ±	7.93	(0.00 - 5.37)	2.08 ±	2.66	(0.00 -7.37) [§]
Draw Drug/Fluid into Syringe	5.05 ±	3.08	(0.21 - 10.20)	1.53 ±	1.08	(0.07 -3.20)
Add/Change IV Fluids	4.80 ±	3.09	(0.70 - 10.60)	1.49 ±	1.07	(0.15 -3.35)
Dispose of Sharps/Trash	4.56 ±	2.32	(2.43 - 5.06)	1.20 ±	0.36	(0.70 -1.70)
Manipulate IV Tubing/stopcock, retrieve stopcock	3.25 ±	1.98	(1.21 - 6.99)	1.10 ±	0.87	(0.10 -2.80)

Place/Retrieve Syringe	3.20 ±	2.21	(1.23 - 7.79)	0.83 ±	0.45	(0.35 -1.67)
Observe IV/Fluids	2.95 ±	2.20	(0.86 - 6.08)	0.83 ±	0.71	(0.18 -2.43)
Open/Close Anesthesia Cart	1.75 ±	1.69	(0.37 - 4.91)	0.42 ±	0.36	(0.12 -1.05)
Prepare Vial for Medication Draw	1.60 ±	1.26	(0.32 - 3.19)	0.42 ±	0.34	(0.10 -0.88)
Remove Wrapping	1.50 ±	0.58	(0.65 - 2.02)	0.44 ±	0.25	(0.17 -0.93)
Assemble Syringe	1.24 ±	0.80	(0.24 - 2.18)	0.35 ±	0.24	(0.07 -0.63)
Manipulate/attach/remove Terminal	1.18 ±	1.34	(0.00 - 2.02)	0.35 ±	0.41	(0.00 -1.27)
Organize Workspace	0.89 ±	0.60	(0.21 - 1.09)	0.24 ±	0.15	(0.07 -0.57)

‡ See Table 1 in published paper for grouped task categorization.

* Includes only tasks that comprised at least 0.33% of maintenance period.

€ Significant difference cardiac vs. non-cardiac cases; p<0.001

§ Significant difference cardiac vs. non-cardiac cases; p<0.01

Table A8. Emergence: Non-Cardiac Cases only (n=20) – Percent Time of All Grouped Drug/Fluid-Related Task Categories ‡

Task Category*	Percent (Mean ± SD (Min-Max))			
Add/Change IV Fluids	17.60	± 15.85	(0.00 -	53.33)
Manipulate IV tubing/stopcock, retrieve stopcock	16.81	± 14.87	(0.00 -	50.53)
Flush/squeeze/adjust IV	12.34	± 15.17	(0.00 -	57.69)
Place/Retrieve Syringe	8.68	± 11.44	(0.00 -	47.06)
Deliver Drug via IV	7.75	± 10.96	(0.00 -	44.93)
Charting Drugs/Fluids Given	6.17	± 12.06	(0.00 -	42.58)
Manipulate IV Pole	4.72	± 5.71	(0.00 -	17.65)
Draw Drug/Fluid into Syringe	3.90	± 8.47	(0.00 -	35.54)
Prepare Vial for Medication Draw	3.75	± 6.39	(0.00 -	25.00)
Manipulate/attach/remove terminal to/from syringe	3.70	± 5.77	(0.00 -	22.92)
Remove Wrapping	3.29	± 8.68	(0.00 -	38.16)
Dispose of Sharps/Trash	2.93	± 3.37	(0.00 -	8.47)
Open/Close Anesthesia Cart	2.83	± 4.07	(0.00 -	13.64)
Assemble Syringe	1.66	± 3.23	(0.00 -	13.00)
Other Drug Task	1.40	± 2.65	(0.00 -	9.71)
Label Syringe	1.21	± 3.44	(0.00 -	13.79)
Observe IV/Fluids	1.08	± 1.82	(0.00 -	6.06)

‡ See Table 1 in published paper for grouped task categorization.

* Includes only tasks that comprised at least 0.33% of emergence period.

Note: Cardiac cases were studied only until bypass; thus, there is no emergence data for these cases.

Table A9. Ten Most Common Task Link Pairs During Induction**Non-Cardiac Cases**

Task 1 ‡	Task 2 ‡	Percent * (mean±SD)	Range % (min-max)
Turn/Manipulate Stopcock	Inject Syringe	6.4 ± 2.7	0.0 – 10.6
Adjust IV (Flow Rate)	Non-Drug/Fluid Task	6.3 ± 6.1	0.0 – 22.8
Attach Syringe to Stopcock	Turn/Manipulate Stopcock	4.8 ± 2.3	0.0 – 10.6
Non-Drug/Fluid Task	Manipulate IV Pole	4.2 ± 3.5	0.0 – 11.8
Non-Drug/Fluid Task	Retrieve Syringe	4.1 ± 2.0	0.0 – 9.5
Manipulate IV Tubing/Stopcock	Non-Drug/Fluid Task	3.5 ± 3.4	0.0 – 13.6
Retrieve Syringe	Place Syringe	3.3 ± 2.4	0.0 – 8.3
Place Syringe	Non-Drug/Fluid Task	3.1 ± 2.4	0.0 – 9.5
Remove Syringe (from IV port)	Place Syringe	2.8 ± 1.7	0.0 – 6.9
Inject Syringe	Remove Syringe (from IV port)	2.6 ± 2.0	0.0 – 8.2

Cardiac Cases

Task 1 ‡	Task 2 ‡	Percent * (mean±SD)	Range % (min-max)
Turn/Manipulate Stopcock	Inject Syringe	6.2 ± 2.2	3.8 – 10.6
Attach Syringe to Stopcock	Turn/Manipulate Stopcock	5.0 ± 0.9	3.8 – 6.3
Adjust IV (Flow Rate)	Non-Drug/Fluid Task	4.2 ± 3.0	1.3 – 8.8
Manipulate IV Tubing/Stopcock	Non-Drug/Fluid Task	3.3 ± 3.0	1.5 – 10.6
Observe IV and Fluid Bags	Non-Drug/Fluid Task	3.3 ± 2.4	1.3 – 7.8
Retrieve Syringe	Attach Syringe to Stopcock	3.2 ± 1.0	2.0 – 4.6
Non-Drug/Fluid Task	Retrieve Syringe	2.9 ± 1.5	0.0 – 5.1
Retrieve Syringe	Place Syringe	2.8 ± 1.5	0.0 – 4.8
Remove Syringe (from IV port)	Place Syringe	2.6 ± 1.1	0.8 – 4.6
Inject Syringe	Remove Syringe (from IV port)	2.3 ± 0.9	0.7 – 3.6

- ‡ See Table 1 in published paper for grouped task categories. In some case, the task order in the table may be misleading since link pairs in both directions (Task 1 → Task 2 and Task 2 → Task 1) are combined (see text for details). However, in many cases, the vast majority of links were in the order implied.
- * Percent of total link pairs in each case. Note that different Non-Drug/Fluid Tasks are all classified into a single task category and thus do not generate link pairs unless preceded or followed by a drug/fluid task. The top ten link pairs comprised an average of 41% and 36% of all link pairs in non-cardiac and cardiac cases, respectively.

Table A10. Ten Most Common Task Link Pairs During Maintenance**Non-Cardiac Cases**

Task 1 ‡	Task 2 ‡	Percent * (mean±SD)	Range % (min-max)
Adjust IV (Flow Rate)	Non-Drug/Fluid Task	6.1 ± 3.8	0.0 – 13.0
Charting Drugs/Fluids Given	Non-Drug/Fluid Task	3.4 ± 2.1	0.0 – 7.1
Remove Wrapping	Dispose of Wrapping	3.3 ± 2.0	0.0 – 6.2
Non-Drug/Fluid Task	Retrieve Syringe	2.3 ± 1.2	0.0 – 5.1
Turn/Manipulate Stopcock	Inject Syringe	2.2 ± 1.5	0.0 – 5.1
Retrieve Needle	Remove Wrapping	2.1 ± 1.5	0.7 – 6.2
Non-Drug/Fluid Task	Open/Close anesthesia cart drawer	2.0 ± 1.3	0.5 ± 5.2
Retrieve Syringe from Drawer	Remove Wrapping	2.0 ± 1.1	0.5 – 4.4
Non-Drug/Fluid Task	Observe IV and Fluids	1.9 ± 2.4	0.0 – 7.9
Open/Close anesthesia cart drawer	Open/Close anesthesia cart drawer	1.9 ± 1.4	0.0 – 5.7

Cardiac Cases

Task 1 ‡	Task 2 ‡	Percent * (mean±SD)	Range % (min-max)
Program Infusion Pump	Non-Drug/Fluid Task	6.4 ± 5.8	0.0 – 16.3
Adjust IV (Flow Rate)	Non-Drug/Fluid Task	5.2 ± 2.0	2.2 – 8.7
Charting Drugs/Fluids Given	Non-Drug/Fluid Task	5.2 ± 4.5	0.5 – 15.0
Non-Drug/Fluid Task	Observe IV and Fluids	3.9 ± 3.2	1.0 – 9.4
Attach Syringe to Stopcock	Turn/Manipulate Stopcock	3.7 ± 1.1	1.7 – 5.0
Turn/Manipulate Stopcock	Inject Syringe	3.3 ± 1.3	1.4 – 5.8
Non-Drug/Fluid Task	Retrieve Syringe	2.8 ± 1.0	1.4 – 4.6
Remove Wrapping	Dispose of Wrapping	2.6 ± 1.2	1.1 – 4.3
Retrieve Syringe	Attach Syringe to Stopcock	2.4 ± 0.8	1.4 – 3.6
Non-Drug/Fluid Task	Open/Close anesthesia cart drawer	1.5 ± 1.0	0.5 – 3.3

- ‡ See Table 1 in published paper for grouped task categories. In some case, the task order in the table may be misleading since link pairs in both directions (Task 1 → Task 2 and Task 2 → Task 1) are combined (see text for details). However, in many cases, the vast majority of links were in the order implied.
- * Percent of total link pairs in each case. Note that different Non-Drug/Fluid Tasks are all classified into a single task category and thus do not generate link pairs unless preceded or followed by a drug/fluid task. The top ten link pairs comprised an average of 27% and 37% of all link pairs in non-cardiac and cardiac cases, respectively.

Figure A1. Task Analysis Data Collection Software User Interface

Drug TA Activity Log 0.8

PREPARATORY TASKS ☐ Open/close anesthesia cart drawer ☐ Retrieve syringe from drawer ☐ Retrieve needle ☐ Retrieve drug vial/ampule ☐ Retrieve alcohol swab ☐ Inspect drug vial/ampule ☐ Place drug vial/ampule ☐ Inspect other ☐ Remove wrapping ☐ Attach needle to syringe ☐ Remove cover from needle ☐ Open vial/ampule ☐ Swab top of drug vial/ampule ☐ Withdraw drug from vial/ampule ☐ Withdraw fluid/drug from IV bag ☐ Label syringe ☐ Recap needle ☐ Remove needle or cap* ☐ Place needleless cap on syringe ☐ Retrieve cap ☐ Handle needle/cap/syringe ☐ Place syringe* Non-Drug/Fluid Task	DISPOSAL TASKS ☐ Dispose of wrapping ☐ Dispose of needle ☐ Dispose of syringe ☐ Dispose of IV materials ☐ Dispose of vial/ampule ☐ Dispose of other IV FLUID TASKS ☐ Observe IV and fluids ☐ Adjust IV (flow rate) ☐ Flush/squeeze IV ☐ Retrieve IV fluids ☐ Hang/unhang IV fluids ☐ Retrieve IV tubing ☐ Attach/remove fluids to tubing ☐ Retrieve stopcock ☐ Manipulate IV tubing/stopcock ☐ Manipulate IV pole MISCELLANEOUS ☐ Insert Unlabeled Task ☐ Other Drug Task MARKERS ☐ Initial Set-up ☐ Induction ☐ Maintenance ☐ On bypass ☐ Post bypass ☐ Emergence ☐ Between-case Set-up ☐ Event ☐ Unsuccessful action ☐ On Break USER OPERATIONS ☐ Begin Time for Next ☐ Replace Last w/ Next ☐ Delete Last	SYRINGE PUMP TASKS ☐ Turn on/off syringe pump ☐ Attach syringe to syringe pump ☐ Attach syringe to stopcock* ☐ Attach tubing to syringe ☐ Insert needle in tubing* ☐ Attach tubing end or needle to IV line* ☐ Program syringe pump ☐ Adjust syringe pump ☐ Refill syringe pump INFUSION PUMP TASKS ☐ Turn on/off infusion pump ☐ Insert tubing into infusion pump ☐ Insert needle in tubing* ☐ Attach tubing end or needle to IV line* ☐ Program infusion pump UNKNOWN ITEMS ☐ Retrieve unknown item ☐ Handle/manipulate unknown item ☐ Place unknown item ☐ Dispose of unknown item
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Case Time

0:00:00

Current Task

1. Set-Up

2. Synch..

3. Begin

Store Data

Stop

Quit

About...

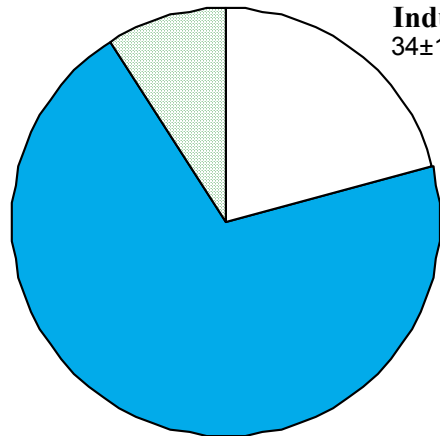
Task List

Figure A2. Duration of Each Case Segment of Study Cases**Non-Cardiac****Emergence**

15±15 (5-34) minutes

Induction

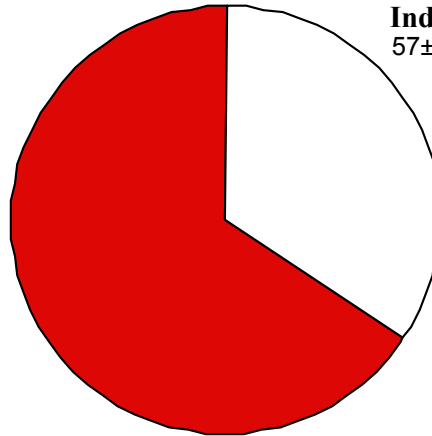
34±13 (18-70) minutes

**Maintenance**

115±67 (21-316) minutes

Cardiac**Induction**

57±13 (31-73) minutes

**Maintenance**

109±31 (69-143) minutes

Figure A3. View of Anesthesia Cart at Two Study Hospitals



A. Top of Anesthesia Cart at VASDHS



B. Top of Anesthesia Cart at UCSD

Figure A4. View of the Drug Infusion System Used During Cardiac Anesthesia Cases.

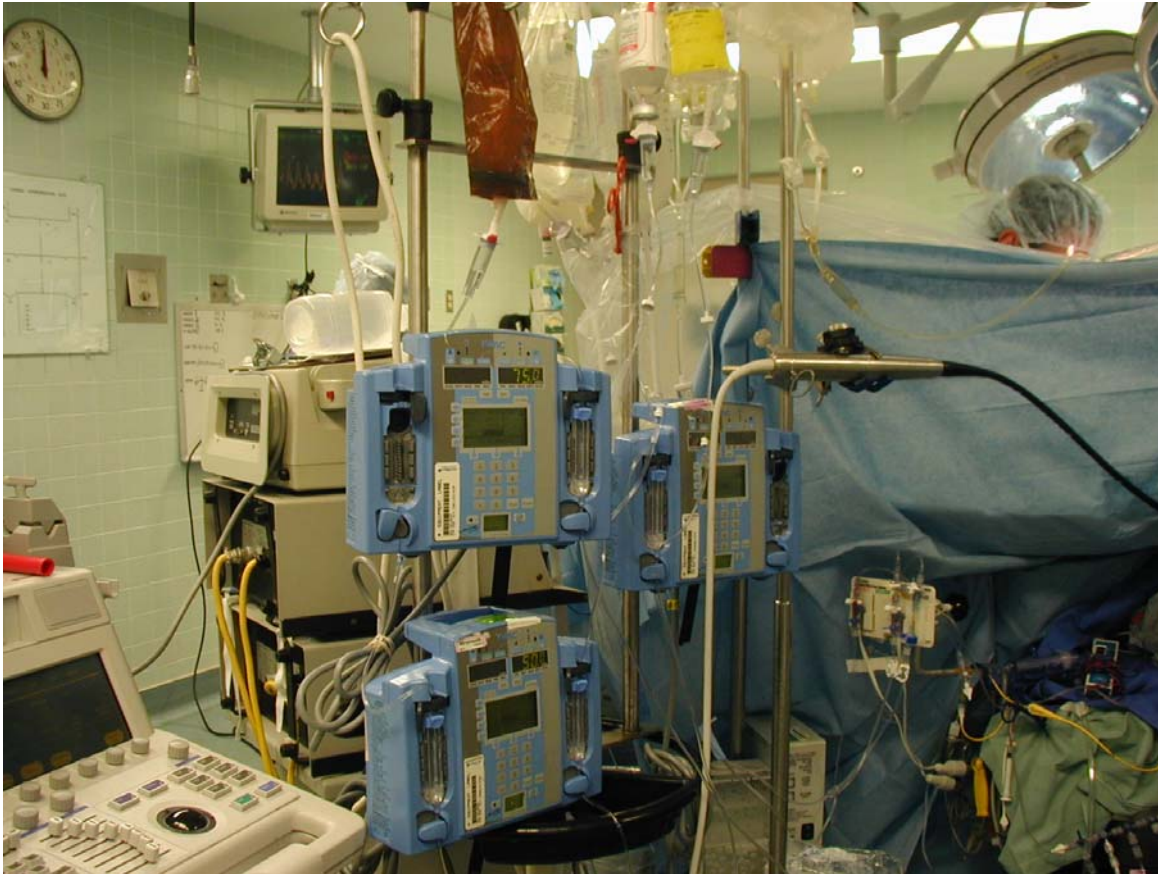


Figure Legends

Figure A1. The figure shows the user interface of the custom task analysis data collection software used in this study. Each of the 66 drug/fluid tasks is listed with an adjacent radio button that is selected by the observer whenever the anesthesia provider is performing that task. Non-drug/fluid tasks are noted using an oversized button. Events and case markers are also indicated. All data is automatically time-stamped and logged into an EXCEL spreadsheet.

Figure A2. The total time (minutes) is depicted for the non-cardiac (n=20) and cardiac (n=8) cases studied. For each case segment shown, the mean $\pm$ standard deviation is provided (as well as the minimum and maximum duration for that segment for all cases). Since data collection during cardiac cases ceased upon initiation of cardiopulmonary bypass, there is no cardiac emergence data.

Figure A3. Photos of the anesthesia carts and workspaces at the two study hospitals. Panel A (upper left) shows the top of the anesthesia cart used at the VA San Diego Healthcare System. Note that the top of the cart is cluttered with used and unused drugs, supplies, and trash. Panel B (lower left) shows the top of the anesthesia cart used at the UCSD Medical Center. The drug label dispensing rolls are seen at the back of both carts.

Figure A4. A view of the anesthesia workspace to the left of the patient's head during a cardiac anesthetic at the VA San Diego Healthcare System. The multiple infusion pumps, poles, lines, and cords create a variety of ergonomic issues including navigation and identification hazards.