

Using Philips MRX for CPR Process and CPR Feedback

ROC

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Background - Variability of CPR

- Performance of CPR is highly variable both in the EMS setting (Wik 2005), and in the hospital setting (Abella 2005; Abella 2005)
- Quality of CPR performance is associated with outcomes (Jim Christenson!)

Background - Feedback

- A before and after study of 284 cases of OOHCA found 4.3% of subjects treated with feedback survived to hospital discharge versus 2.9% of subjects treated without feedback (Kramer-Johansen 2006).
- A before-and-after study of 156 cases of in-hospital cardiac arrest found no effect on short-term outcomes despite improvement in CPR compliance with guidelines when using feedback (Abella 2007).

Kramer-Johansen 2006

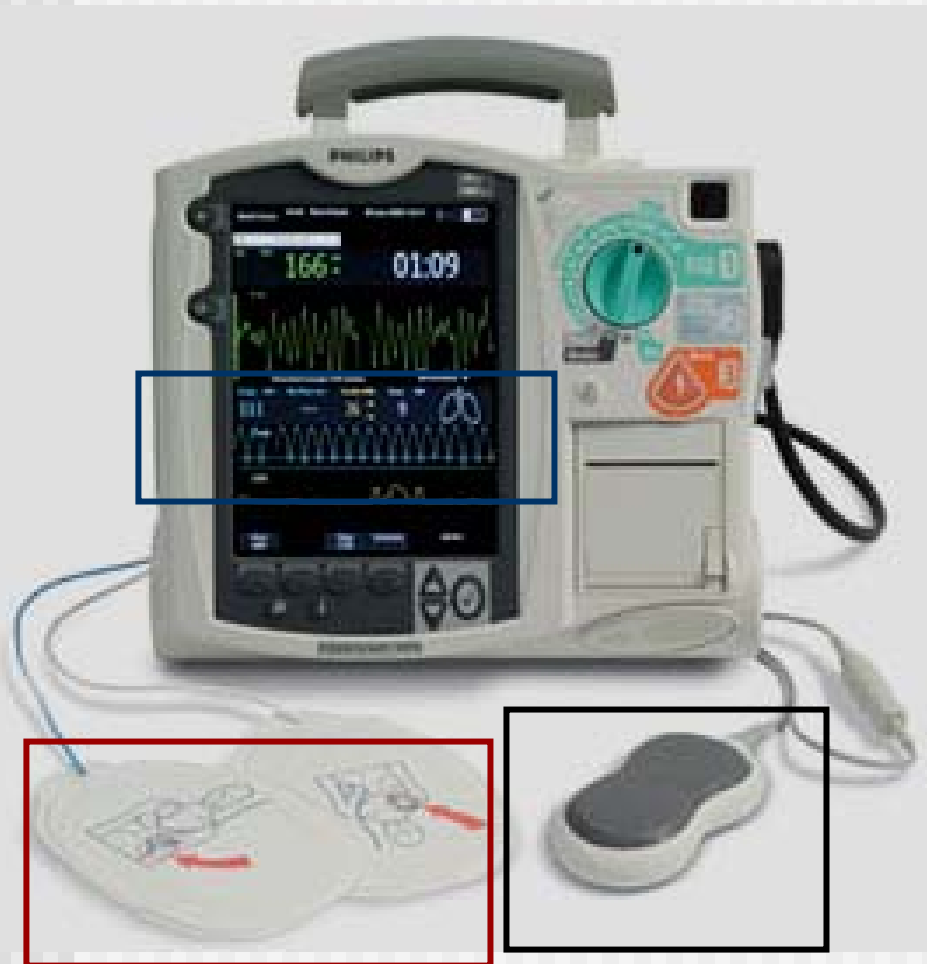
	Baseline	Feedback		Feedback	
	Intention to treat	Intention to treat	P-values	Actually treated	P-values
All rhythms	241	117		94	
Admitted alive	42 (17)	27 (23)	0.3	27 (29)	0.03
Discharged alive	7 (2.9)	5 (4.3)	0.7	5 (5.3)	0.5
VF as initial rhythm	98	38		33	
Admitted alive	25 (26)	11 (29)	0.8	11 (33)	0.5
Discharged alive	7 (7.1)	2 (5.3)	1	2 (6.1)	1
nonVF as initial rhythm	143	79		61	
Admitted alive	17 (12)	16 (20)	0.1	16 (26)	0.02
Discharged alive	0 (0)	3 (3.8)	0.04	3 (4.9)	0.03

Philips MRX and Q-CPR



- Accelerometer can measure chest compressions
- ETCO2 measures ventilation
- Impedance is backup
- CPR Feedback
 - Philips MRX talks / beeps to remind compliance with CPR guidelines

Philips Q-CPR



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- ETCO2 measures ventilation
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- CPR Feedback
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Getting the Data

- Treat a patient
- Go to administration screen and copy data file to the memory card (a standard PCI card)
 - Need to collect data before another 50 cases or so are recorded or it will be overwritten
- Take memory card and read it on computer using QCPR software

Philips Data - QCPR Screen



Return of Spontaneous Circulation



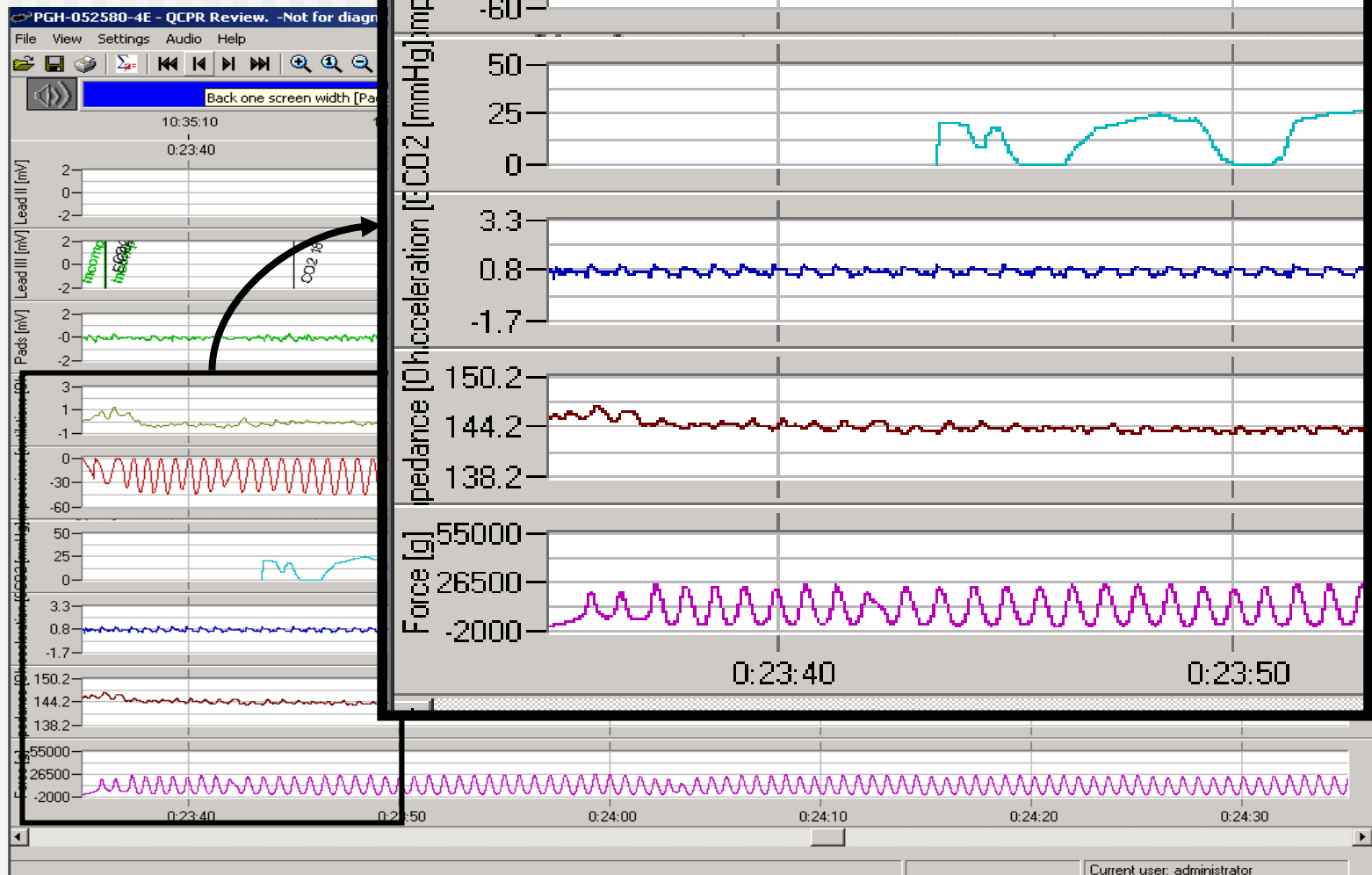
Closer View - 1 minute / window



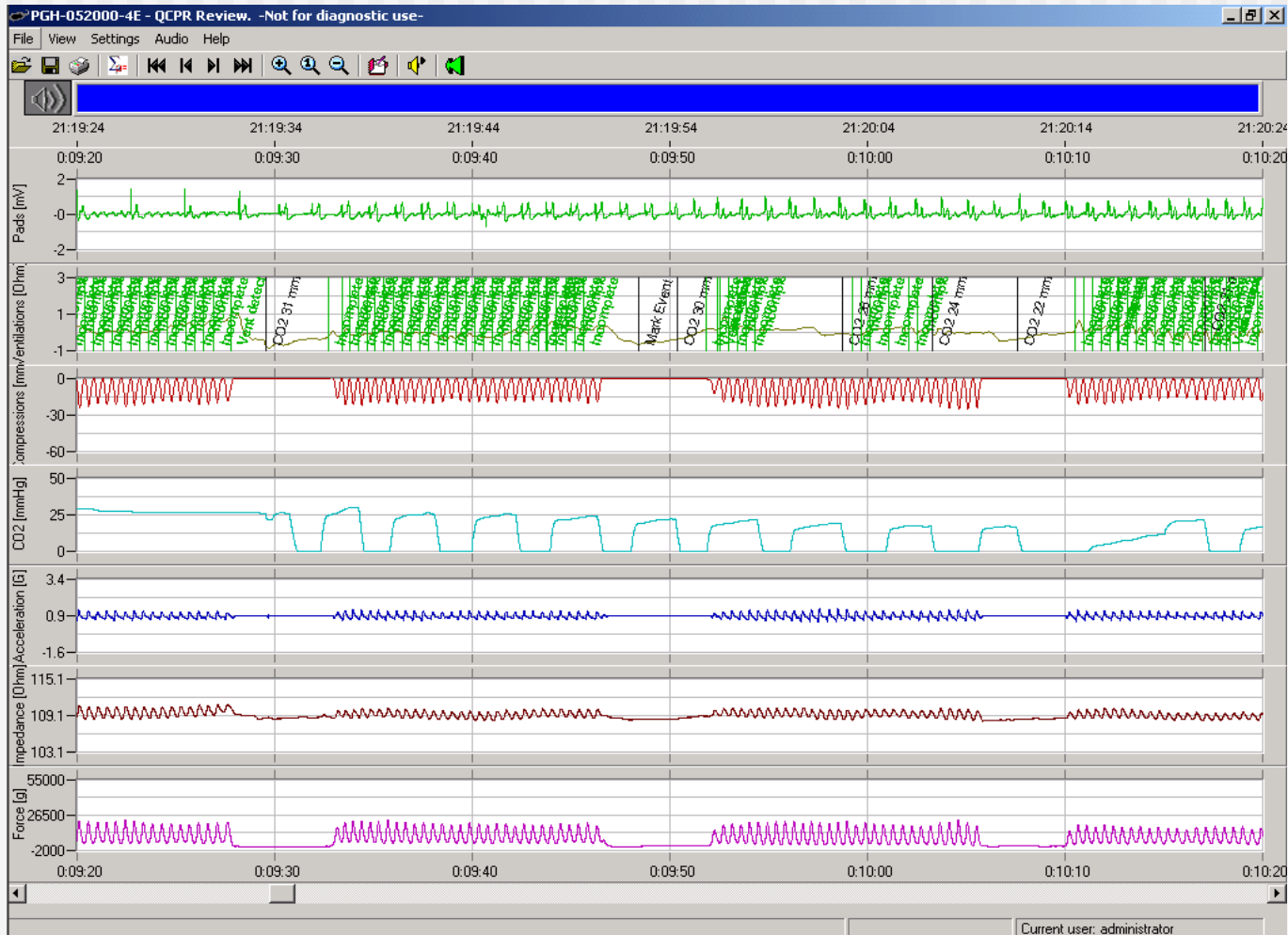
Closer View



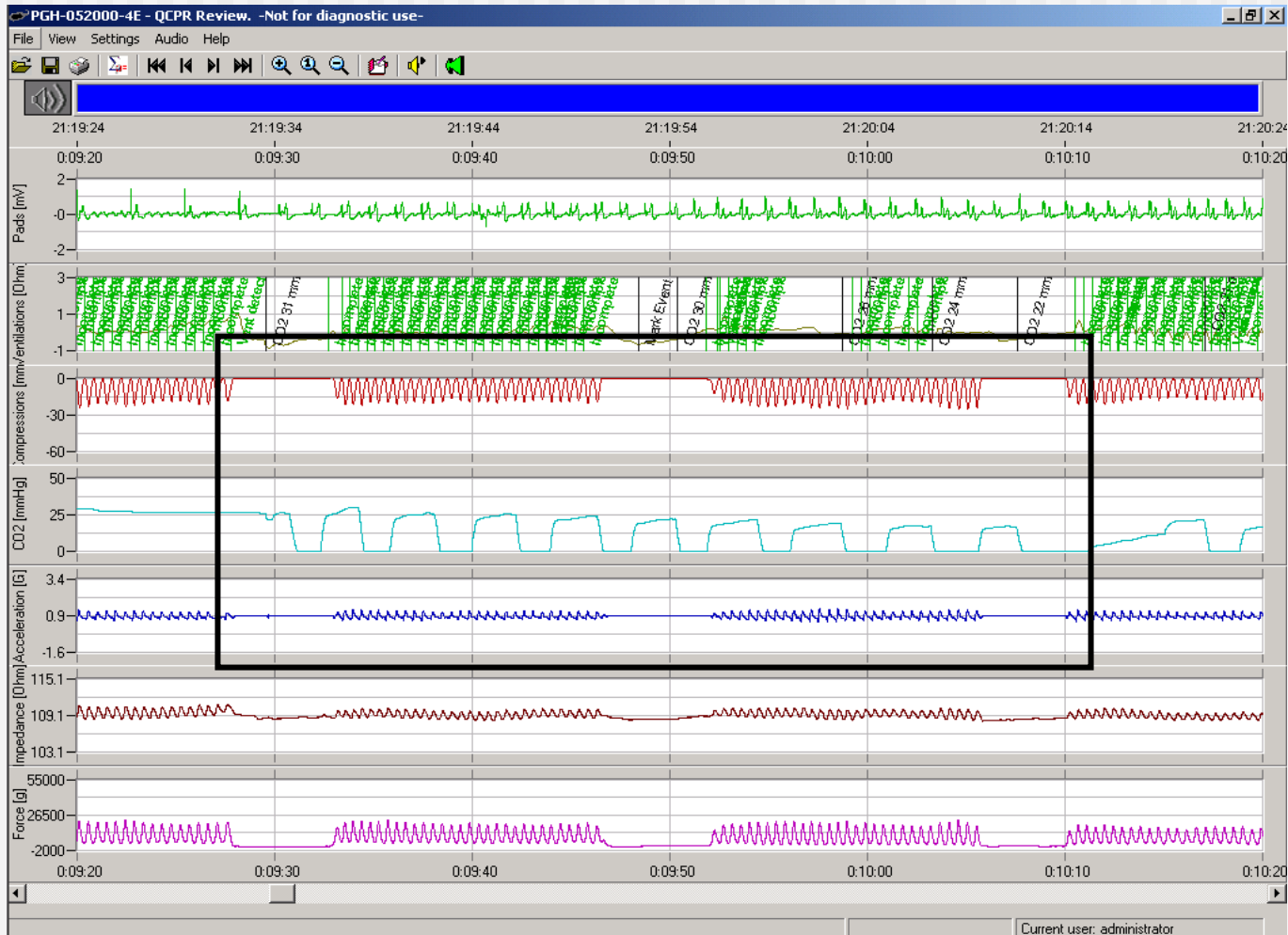
Closer View



Hyperventilation

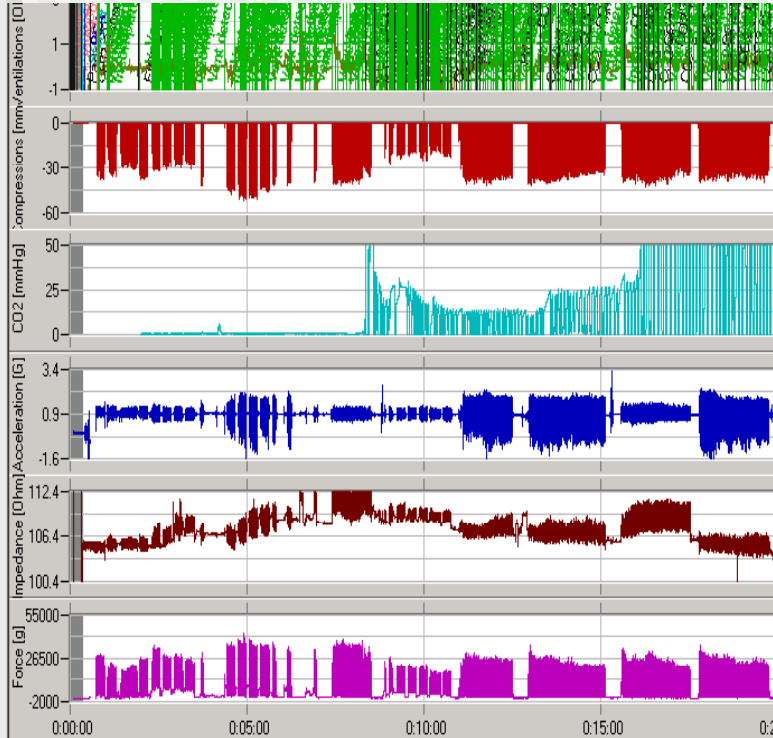


Hyperventilation





Details: What can you measure?



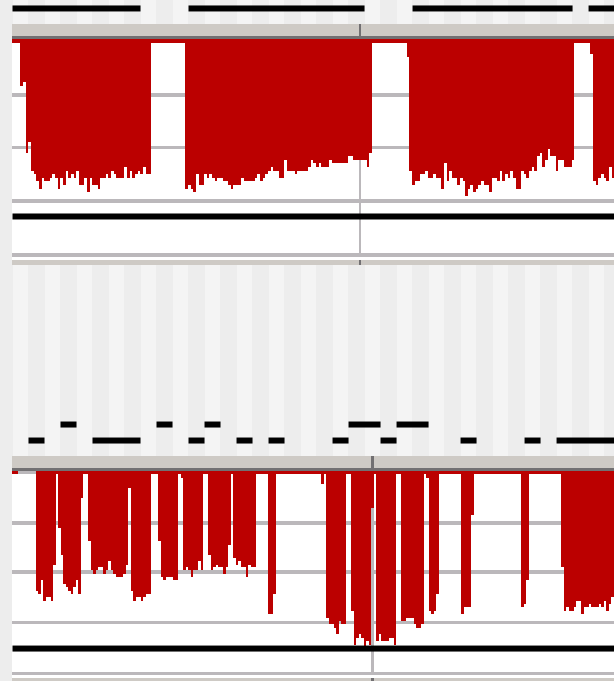
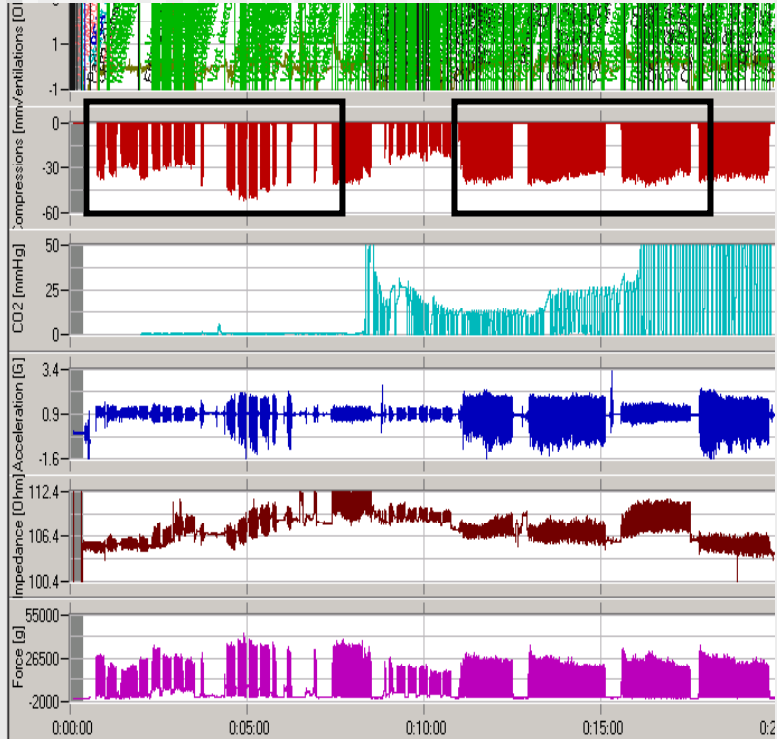
CPR Fraction = Proportion of time when compressions are being done

Compression Depth

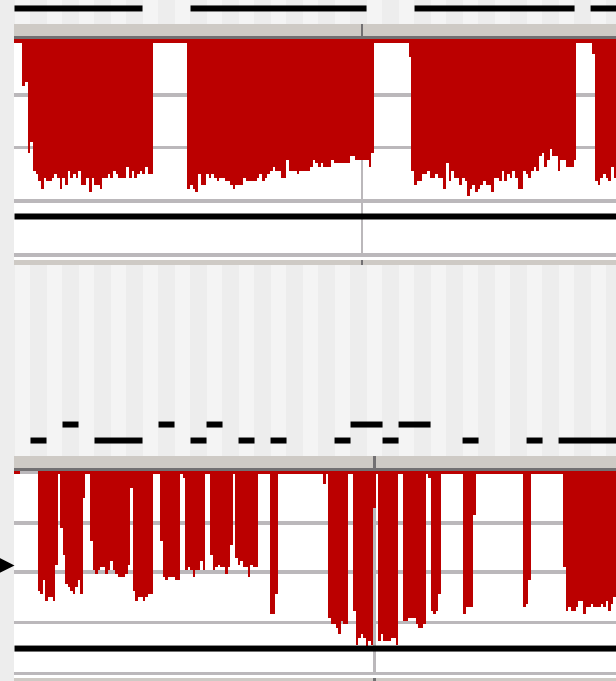
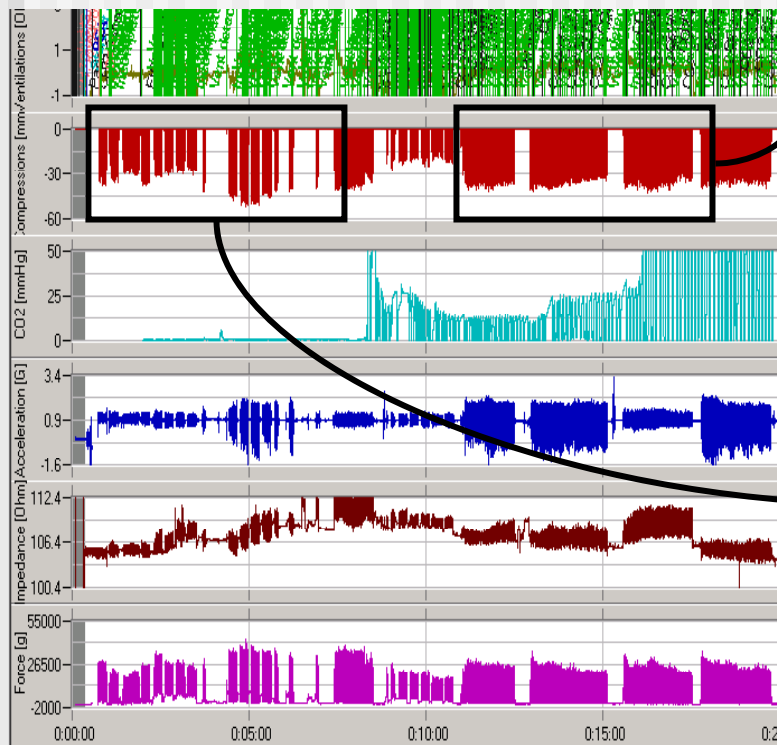
Complete Release = Not “leaning on the patient” during upstroke

Ventilation

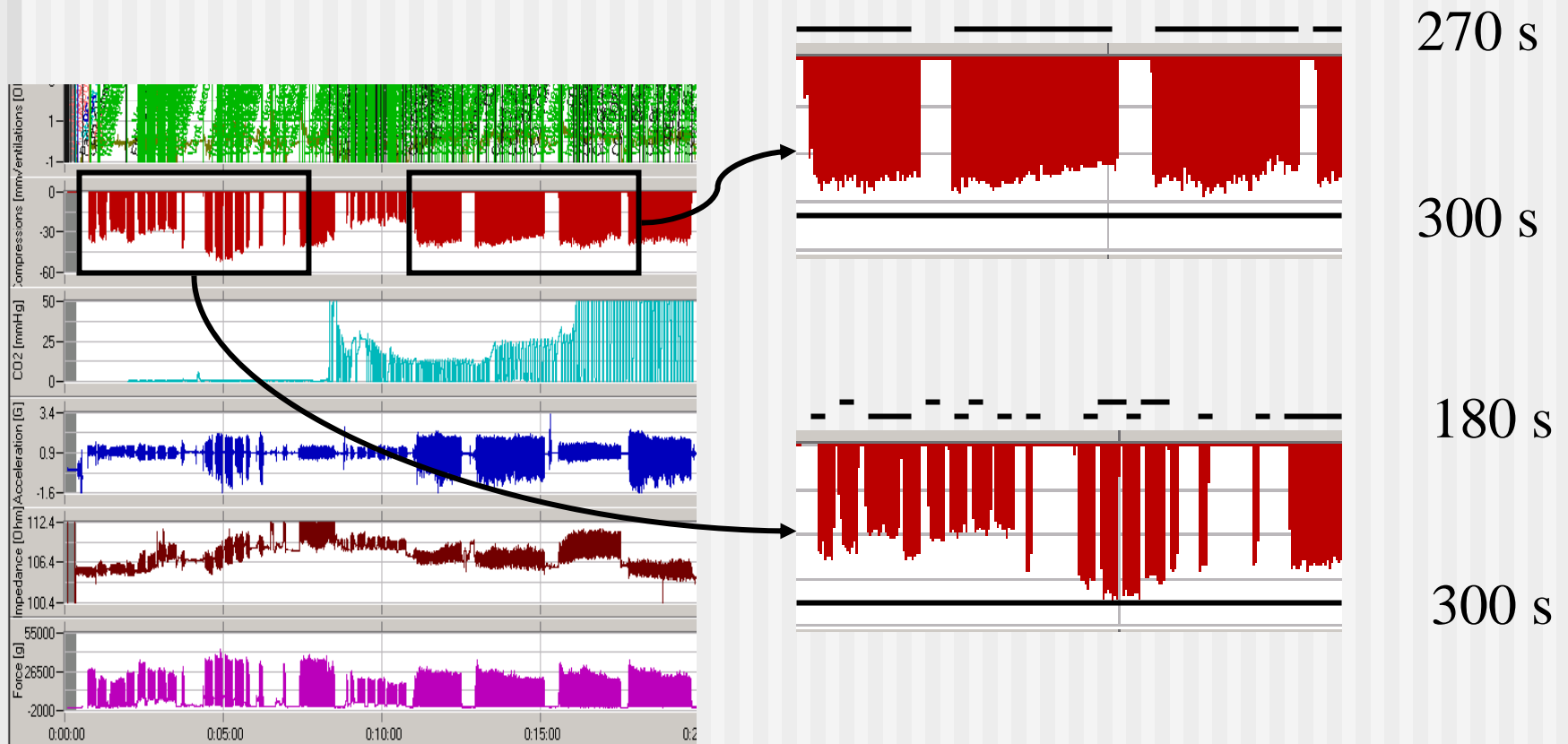
Details - CPR Fraction



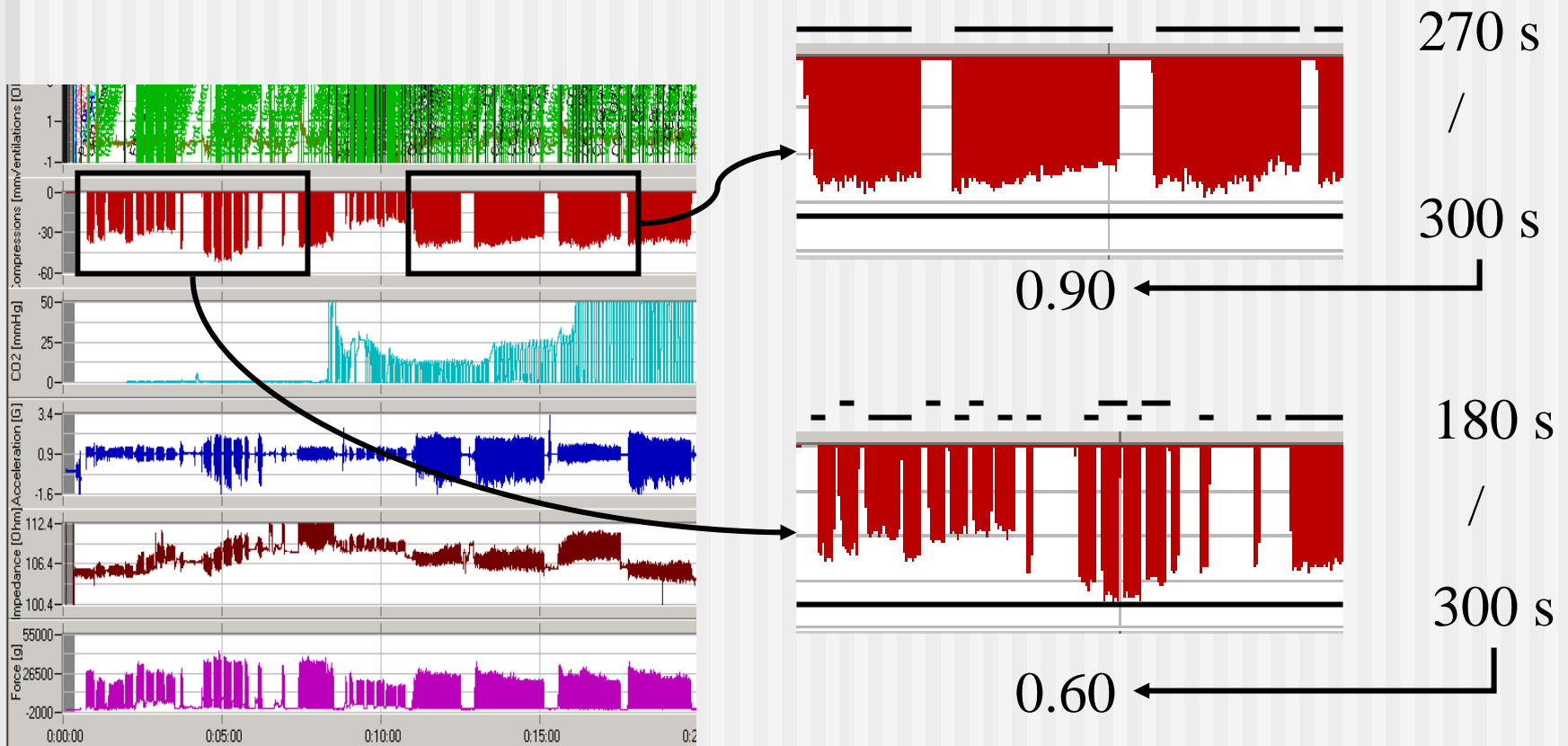
Details - CPR Fraction



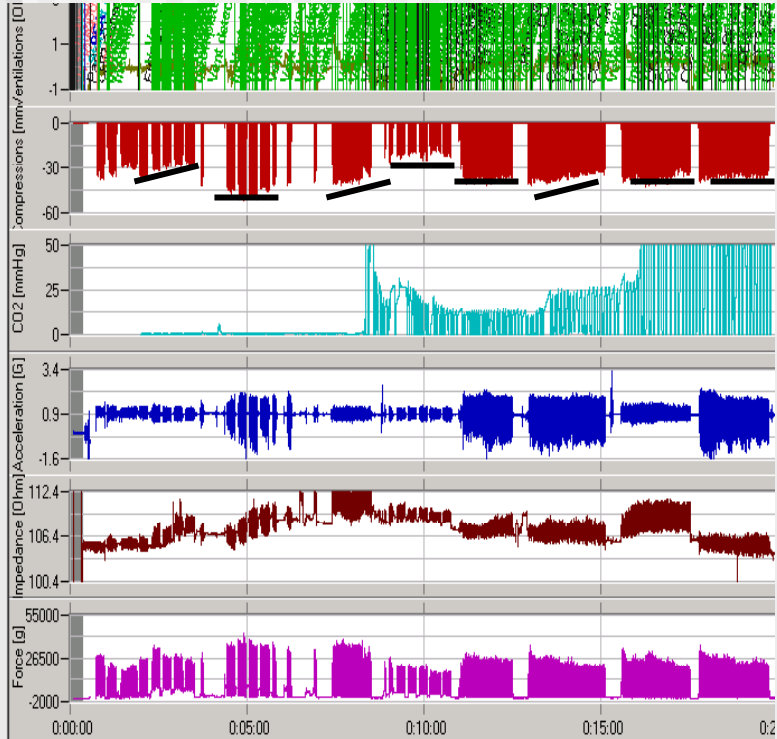
Details - CPR Fraction



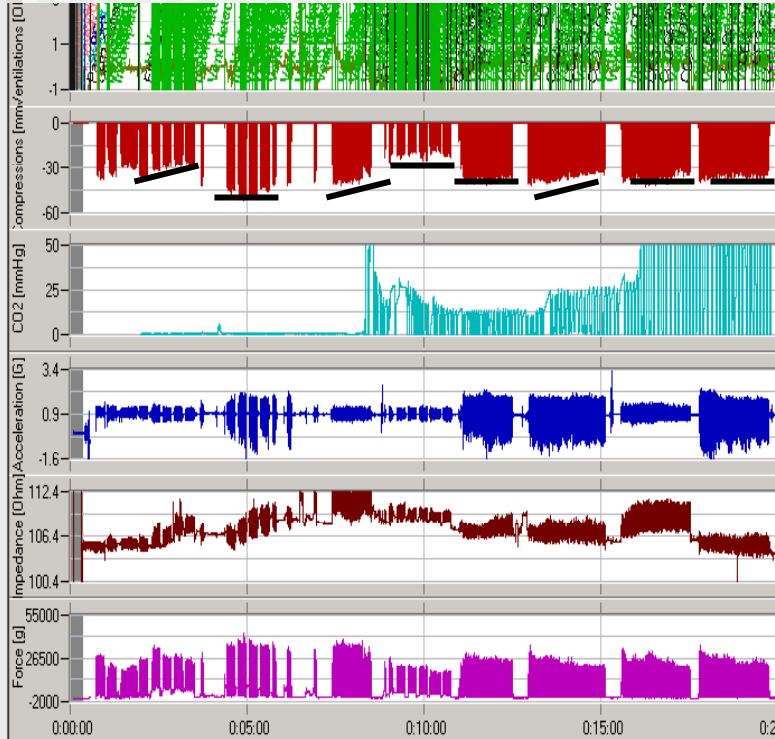
Details - CPR Fraction



Details - Compression Depth



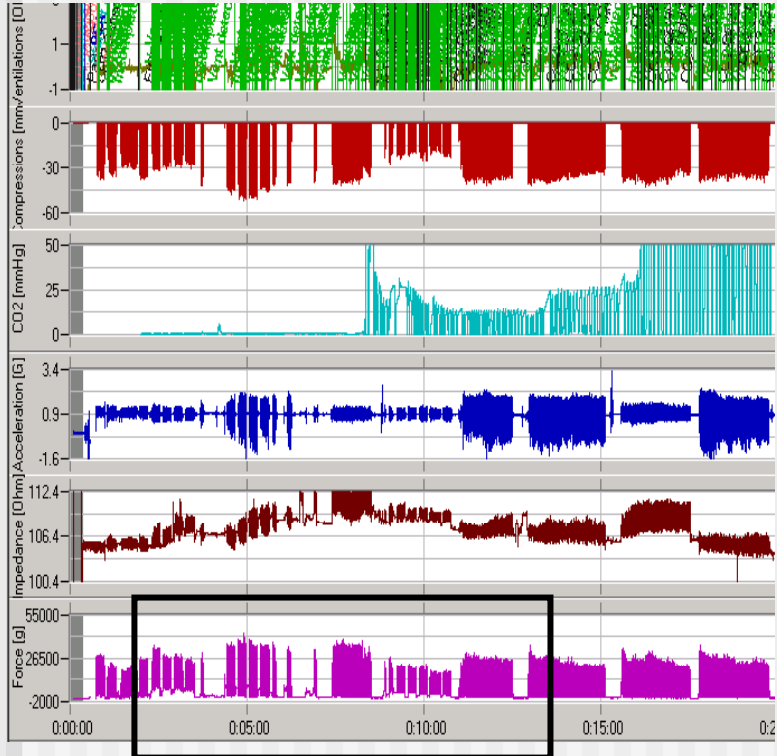
Details - Compression Depth



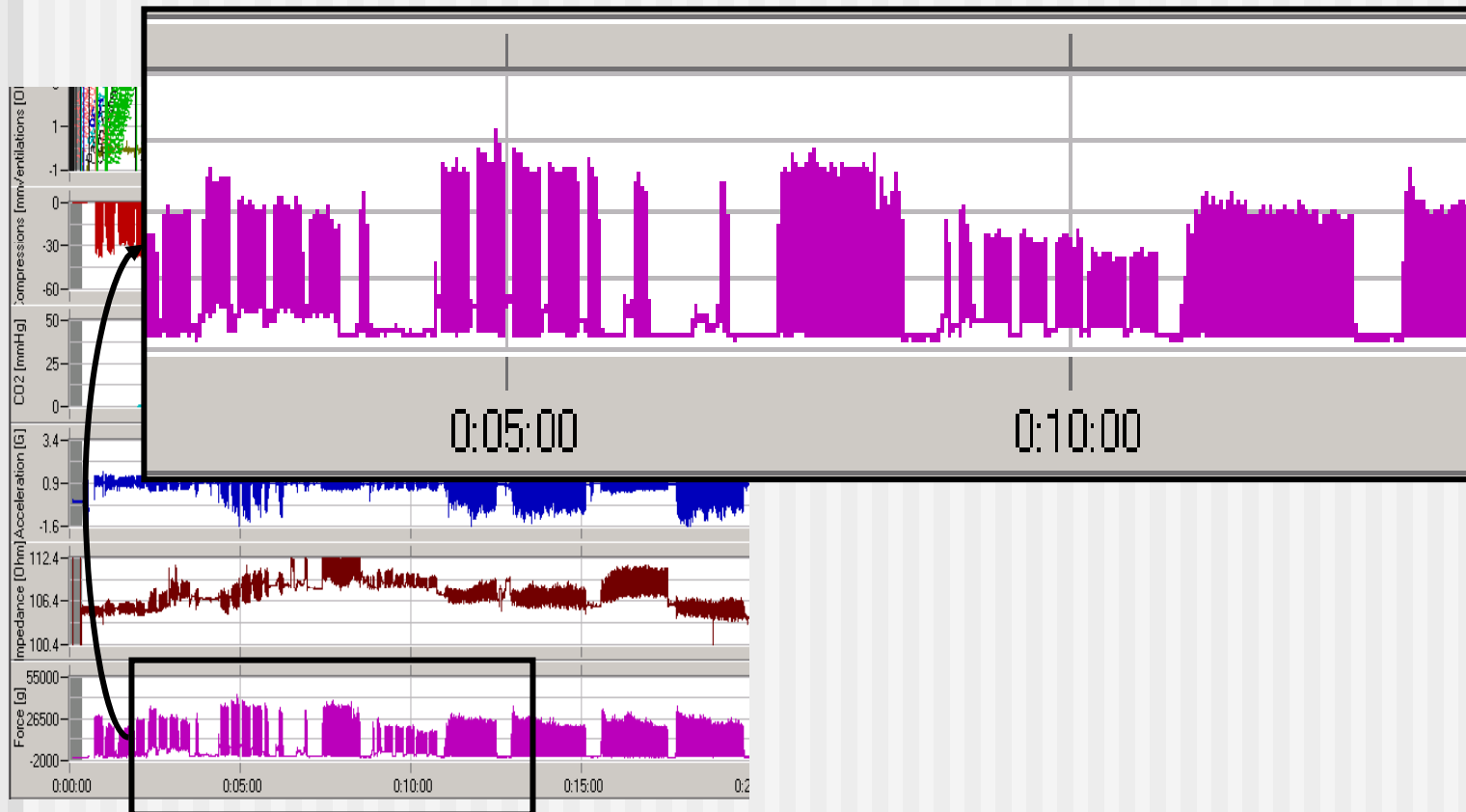
Compression Depth ranges from 25-55 mm.

Calculate average depth over each minute.

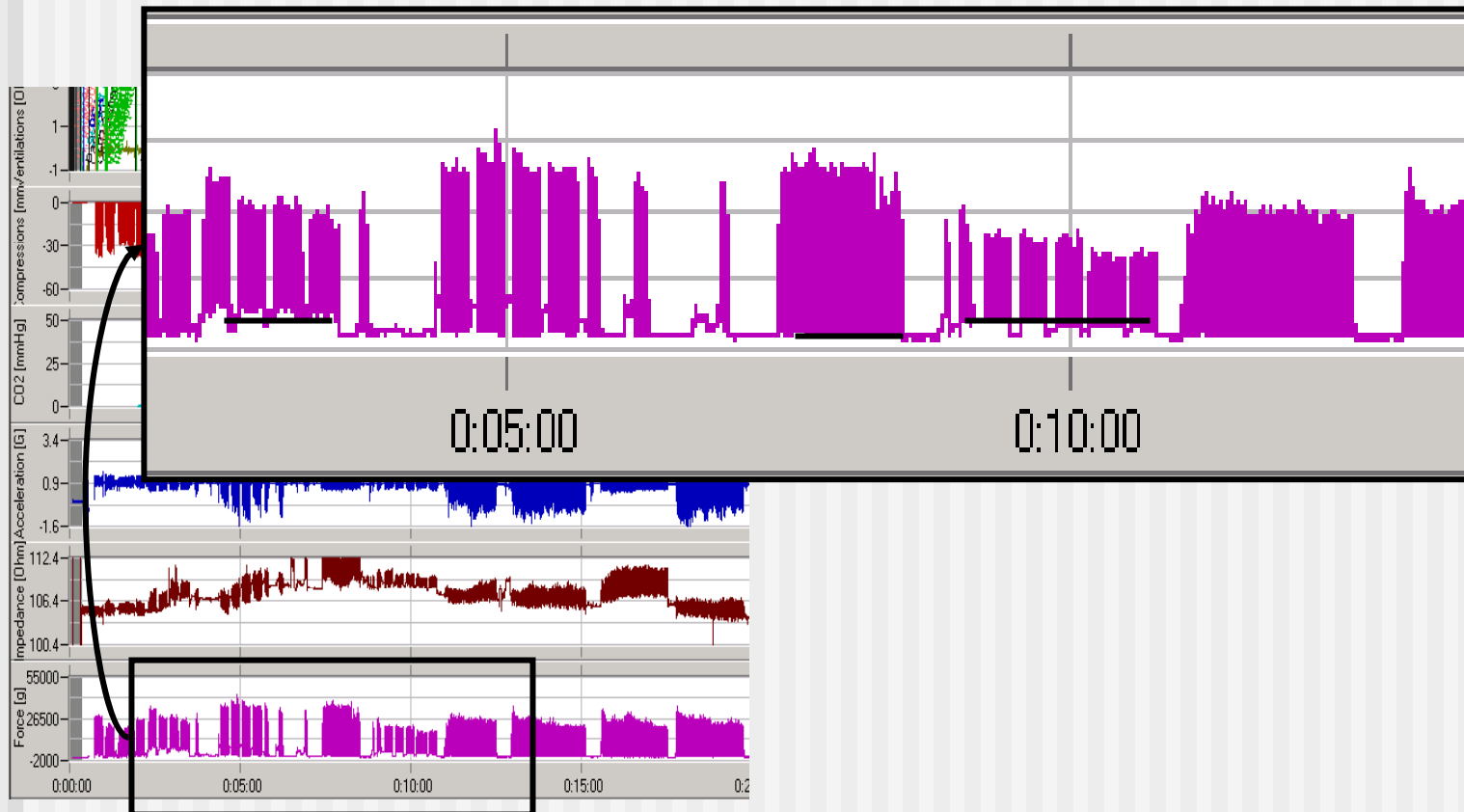
Details - Incomplete release



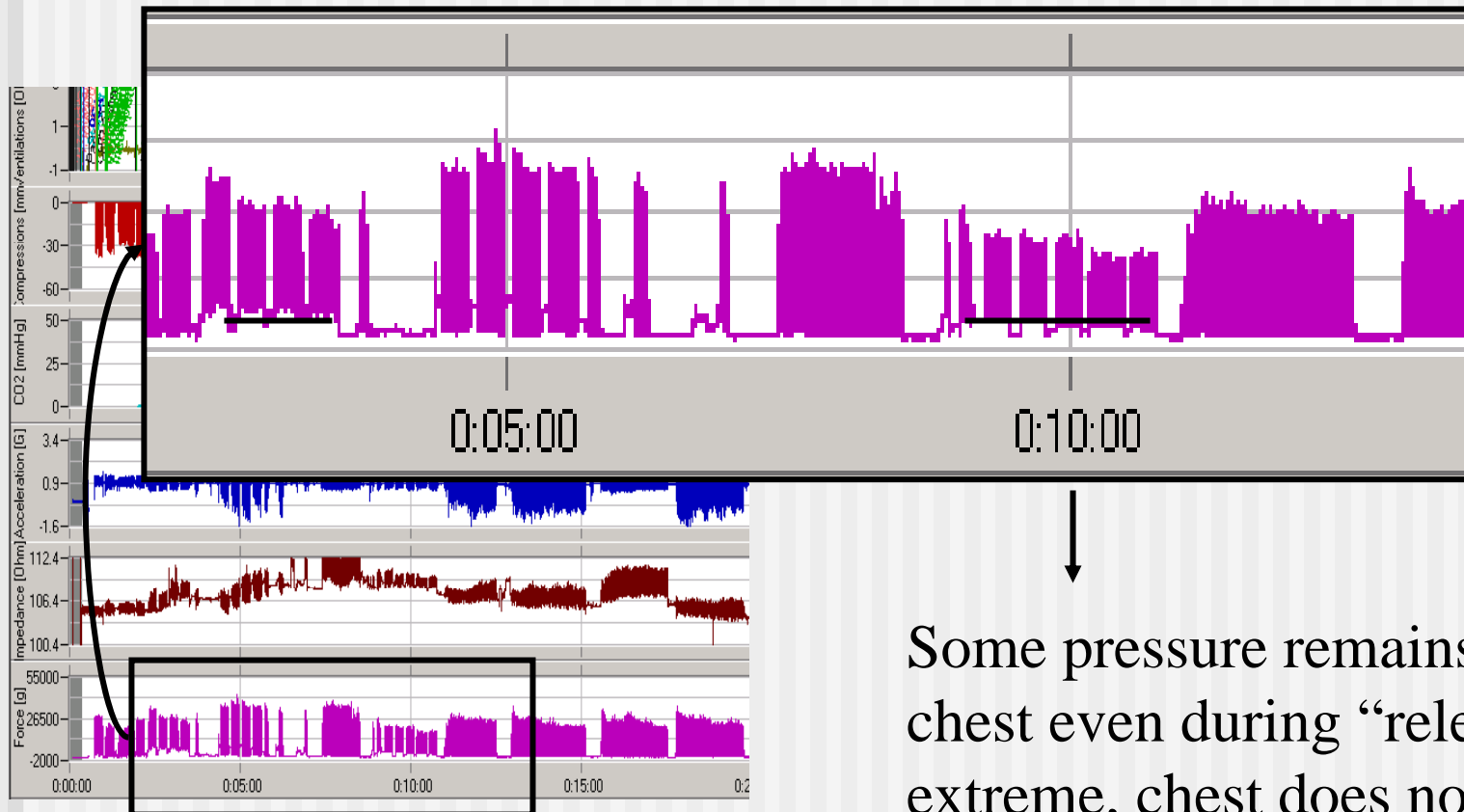
Details - Incomplete release



Details - Incomplete release

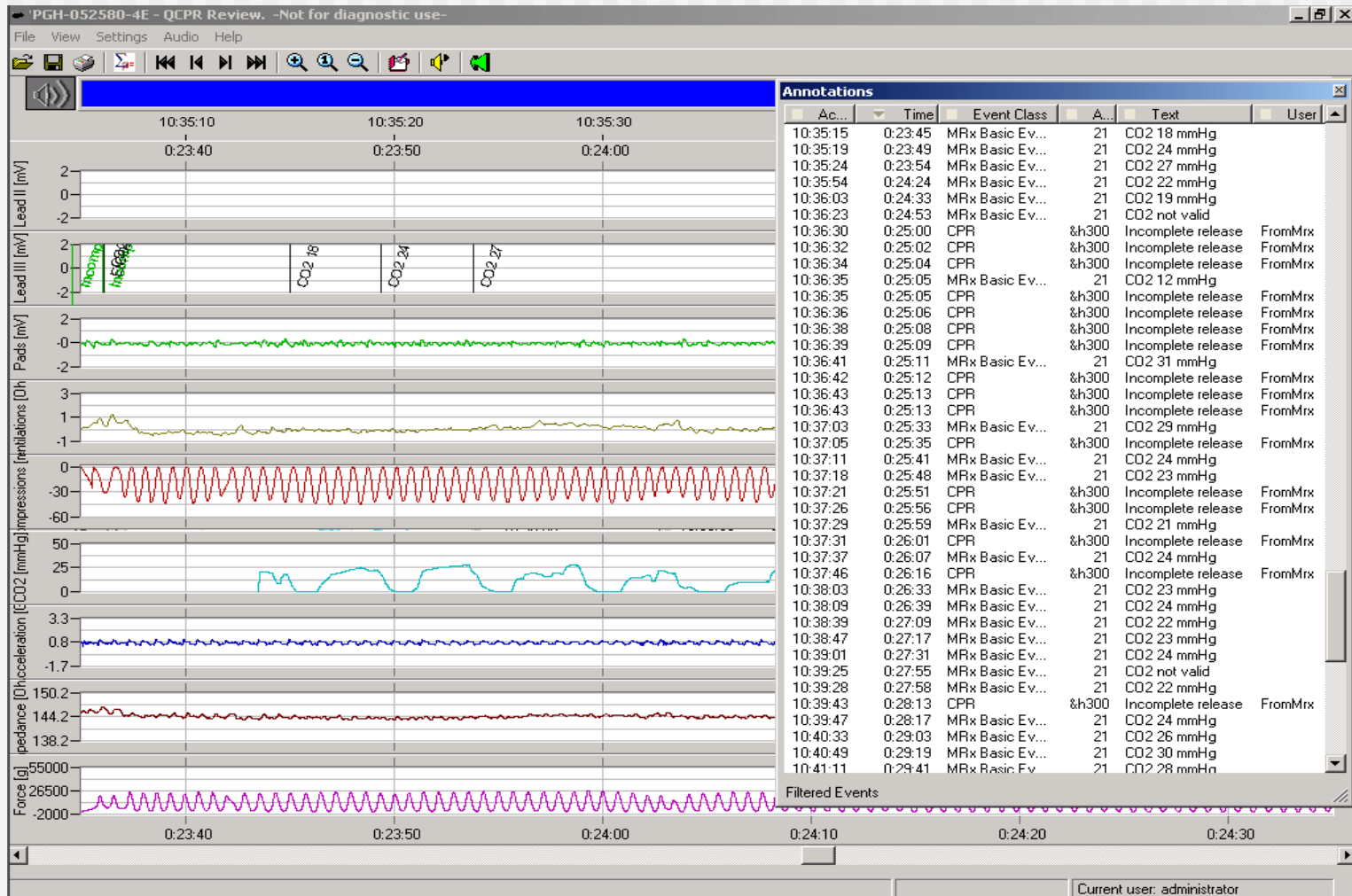


Details - Incomplete release



Some pressure remains on chest even during “release”. In extreme, chest does not recoil all the way to 0 mm.

Data Extraction



Q-CPR Data Export

Intubation I:
 Rhythm anr
 CPR annot:
 Start / Stop #####
 Start time: #####
 Episode ID:PGH-024096-6
 Number of warnings / errors during calculation: 0

EpisodeID	Version	Cat	Seq	No	Start	Length	Comp Count	Comp OK	Comp Too Deep	Comp Too Shallow	Comp Depth	Comp Leaning	Comp Rate	Comp DC	Vent Count	Infltd	InflZ	FT	FR	NFT	NFR	NSC	NFT / NSC	Comp Rate	Vent Rate	Comp Adeq
070116-06-v2.0.1	-	-	i000	01:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i001	02:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i002	03:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i003	04:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i004	05:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i005	06:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i006	07:10.0	01:00.0	0	0								0	0	0%	0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i007	08:10.0	01:00.0	7	0	0		7	22	7	159	49%	5	1186	1048	2.5	4%	57.5	96%	60	96%	7	5	0%
070116-06-v2.0.1	-	-	i008	09:10.0	01:00.0	50	1	0		47	33	43	89	42%	4	1002	950	33	55%	27	45%	60	45%	50	4	6%
070116-06-v2.0.1	-	-	i009	10:10.0	01:00.0	18	0	0		18	33	17	84	43%	5	896	924	12.8	21%	47.2	79%	60	79%	18	5	0%
070116-06-v2.0.1	-	-	i010	11:10.0	01:00.0	0	0								10	769	1144	0	0%	60	100%	60	100%	0	10	-
070116-06-v2.0.1	-	-	i011	12:10.0	01:00.0	0	0								11	955	1417	0	0%	60	100%	60	100%	0	11	-
070116-06-v2.0.1	-	-	i012	13:10.0	01:00.0	86	0	0			27	86	115	48%	9	1307	1092	44.8	75%	15.2	25%	60	25%	86	9	0%
070116-06-v2.0.1	-	-	i013	14:10.0	01:00.0	115	0	0		115	22	115	115	48%	16	958	845	58.8	98%	1.2	2%	60	2%	115	16	0%
070116-06-v2.0.1	-	-	i014	15:10.0	01:00.0	34	0	0		34	24	32	110	49%	9	924	993	18.1	30%	41.9	70%	60	70%	34	9	0%
070116-06-v2.0.1	-	-	i015	16:10.0	01:00.0	116	68	0		24	39	40	123	48%	12	1215	833	56.4	94%	3.6	6%	60	6%	116	12	79%
070116-06-v2.0.1	-	-	i016	17:10.0	01:00.0	93	81	0		3	41	11	124	45%	8	1381	827	45.1	75%	14.9	25%	60	25%	93	8	97%
070116-06-v2.0.1	-	-	i017	18:10.0	01:00.0	92	92	0		0	43	0	126	47%	10	956	987	43.9	73%	16.1	27%	60	27%	92	10	100%
070116-06-v2.0.1	-	-	i018	19:10.0	01:00.0	91	89	0		2	42	0	126	47%	8	1413	1033	43	72%	17	28%	60	28%	91	8	98%
070116-06-v2.0.1	-	-	i019	20:10.0	01:00.0	92	91	1		0	46	0	126	48%	14	1242	986	43.6	73%	16.4	27%	60	27%	92	14	100%
070116-06-v2.0.1	-	-	i020	21:10.0	01:00.0	88	85	3		0	45	0	125	49%	12	1049	818	42.4	71%	17.6	29%	60	29%	88	12	100%
070116-06-v2.0.1	-	-	i021	22:10.0	01:00.0	111	95	2		1	45	13	114	47%	14	1247	1016	58.2	97%	1.8	3%	60	3%	111	14	99%
070116-06-v2.0.1	-	-	i022	23:10.0	01:00.0	85	69	5		6	46	6	103	45%	14	1211	1155	49.4	82%	10.6	18%	60	18%	85	14	93%
070116-06-v2.0.1	-	-	i023	24:10.0	01:00.0	99	89	6		3	46	3	99	43%	14	875	852	60	100%	0	0%	60	0%	99	14	97%
070116-06-v2.0.1	-	-	i024	25:10.0	01:00.0	89	65	2		18	44	15	98	44%	14	960	911	54.2	90%	5.8	10%	60	10%	89	14	80%
070116-06-v2.0.1	-	-	i025	26:10.0	01:00.0	113	0	0		113	31	110	113	49%	1	620	375	60	100%	0	0%	60	0%	113	1	0%
070116-06-v2.0.1	-	-	i026	27:10.0	01:00.0	48	0	0		48	30	47	116	49%	0			24.9	41%	35.1	59%	60	59%	48	0	0%
070116-06-v2.0.1	-	-	i027	28:10.0	01:00.0	101	0	0		101	31	82	116	50%	0			52.3	87%	7.7	13%	60	13%	101	0	0%
070116-06-v2.0.1	-	-	i028	29:10.0	01:00.0	18	0	1		1	43	17	114	46%	10	1433	1253	9.4	16%	50.6	84%	60	84%	18	10	94%
070116-06-v2.0.1	-	-	i029	30:10.0	01:00.0	120	3	3		3	43	114	120	48%	6	1365	914	60	100%	0	0%	60	0%	120	6	98%
070116-06-v2.0.1	-	-	i030	31:10.0	01:00.0	116	25	3		9	42	87	116	48%	12	1545	1010	60	100%	0	0%	60	0%	116	12	92%
070116-06-v2.0.1	-	-	i031	32:10.0	01:00.0	22	17	0		1	44	4	116	48%	0			11.2	19%	48.8	81%	60	81%	22	0	95%
070116-06-v2.0.1	-	-	i032	33:10.0	01:00.0	110	93	1		10	43	8	119	46%	11	809	751	55.3	92%	4.7	8%	60	8%	110	11	91%
070116-06-v2.0.1	-	-	i033	34:10.0	01:00.0	94	86	1		7	44	0	117	46%	14	1282	883	47.9	80%	12.1	20%	60	20%	94	14	93%
070116-06-v2.0.1	-	-	i034	35:10.0	01:00.0	75	62	2		11	41	1	116	43%	16	1098	1309	38	63%	22	37%	60	37%	75	16	85%
070116-06-v2.0.1	-	-	i035	36:10.0	01:00.0	108	67	2		39	38	6	114	44%	16	784	1072	57	95%	3	5%	60	5%	108	16	64%
070116-06-v2.0.1	-	-	i036	37:10.0	01:00.0	42	19	0		19	35	9	118	44%	11	1183	1105	20.8	35%	39.2	65%	60	65%	42	11	55%
070116-06-v2.0.1	-	-	i037	38:10.0	01:00.0	0	0	0				0	0	0%	0			0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i038	39:10.0	01:00.0	0	0	0				0	0	0%	0			0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	i039	40:10.0	01:00.0	66	16	0		50	33	7	120	49%	0			33.2	55%	26.8	45%	60	45%	66	0	24%
070116-06-v2.0.1	-	-	i040	41:10.0	01:00.0	107	10	0		97	31	26	120	51%	0			53.1	89%	6.9	12%	60	12%	107	0	9%
070116-06-v2.0.1	-	-	i041	42:10.0	01:00.0	65	37	0		20	39	15	113	49%	0			34.1	57%	25.9	43%	60	43%	65	0	69%
070116-06-v2.0.1	-	-	i042	43:10.0	01:00.0	112	37	0		74	34	19	112	49%	0			60	100%	0	0%	60	0%	112	0	34%
070116-06-v2.0.1	-	-	i043	44:10.0	01:00.0	118	14	2		99	31	45	118	49%	0			60	100%	0	0%	60	0%	118	0	16%
070116-06-v2.0.1	-	-	i044	45:10.0	01:00.0	86	5	1		72	30	38	120	47%	0			42.9	71%	17.1	29%	60	29%	86	0	16%
070116-06-v2.0.1	-	-	i045	46:10.0	01:00.0	98	9	0		63	33	60	114	48%	0			50	83%	10	17%	60	17%	98	0	36%
070116-06-v2.0.1	-	-	i046	47:10.0	01:00.0	111	11	1		97	28	41	117	49%	0			56.6	94%	3.4	6%	60	6%	111	0	13%
070116-06-v2.0.1	-	-	i047	48:10.0	01:00.0	84	5	0		77	27	25	121	47%	0			40	67%	20	33%	60	33%	84	0	8%
070116-06-v2.0.1	-	-	i048	49:10.0	01:00.0	111	7	6		91	33	63	115	50%	0			58.2	97%	1.8	3%	60	3%	111	0	18%
070116-06-v2.0.1	-	-	i049	50:10.0	01:00.0	119	5	0		100	30	95	119	47%	0			58.8	98%	1.2	2%	60	2%	119	0	16%
070116-06-v2.0.1	-	-	i050	51:10.0	01:00.0	105	7	3		88	30	67	112	47%	0			54.5	91%	5.5	9%	60	9%	105	0	16%
070116-06-v2.0.1	-	-	i051	52:10.0	01:00.0	127	1	0		113	29	110	127	48%	0			58.9	98%	1.1	2%	60	2%	127	0	11%

Q-CPR Data Export

Intubation I:
 Rhythm anr
 CPR annot:
 Start / Stop: #####
 Start time: #####
 Episode ID: BCH_024096.6

Start	Length	Comp Count	Comp OK	Comp Too Deep	Comp Too Shallow	Comp Depth	Comp Leaning	Comp Rate	Comp DC	Vent Count	Infldt	InfldZ	FT	FR	NFT	NFR									
01:10.0	01:00.0	0								0			0	0%	60	100%									
02:10.0	01:00.0	0								0			0	0%	60	100%									
03:10.0	01:00.0	0								0			0	0%	60	100%									
04:10.0	01:00.0	0								0			0	0%	60	100%									
05:10.0	01:00.0	0								0			0	0%	60	100%									
06:10.0	01:00.0	0								0			0	0%	60	100%									
07:10.0	01:00.0	0								0			0	0%	60	100%									
08:10.0	01:00.0	7	0	0	7	22	7	159	49%	5	1186	1048	2.5	4%	57.5	96%									
09:10.0	01:00.0	50	1	0	47	33	43	89	42%	4	1002	950	33	55%	27	45%									
10:10.0	01:00.0	18	0	0	18	33	17	84	43%	5	896	924	12.8	21%	47.2	79%									
11:10.0	01:00.0	0								10	769	1144	0	0%	60	100%									
12:10.0	01:00.0	0								11	955	1417	0	0%	60	100%									
13:10.0	01:00.0	86	0	0	86	27	86	115	48%	9	1307	1092	44.8	75%	15.2	25%									
070116-06-v2.0.1	-	-	024	25:10.0	01:00.0	69	69	2	16	44	15	36	44%	1	620	375	34.2	30%	3.8	10%	60	10%	69	14	60%
070116-06-v2.0.1	-	-	025	26:10.0	01:00.0	113	0	0	113	31	110	113	49%	1	620	375	60	100%	0	0%	60	0%	113	1	0%
070116-06-v2.0.1	-	-	026	27:10.0	01:00.0	48	0	0	48	30	47	116	49%	0			24.9	41%	35.1	59%	60	59%	48	0	0%
070116-06-v2.0.1	-	-	027	28:10.0	01:00.0	101	0	0	101	31	82	116	50%	0			52.3	87%	7.7	13%	60	13%	101	0	0%
070116-06-v2.0.1	-	-	028	29:10.0	01:00.0	18	0	1	1	43	17	114	46%	10	1433	1253	9.4	16%	50.6	84%	60	84%	18	10	94%
070116-06-v2.0.1	-	-	029	30:10.0	01:00.0	120	3	3	3	43	114	120	48%	6	1365	914	60	100%	0	0%	60	0%	120	6	98%
070116-06-v2.0.1	-	-	030	31:10.0	01:00.0	116	25	3	9	42	87	116	48%	12	1545	1010	60	100%	0	0%	60	0%	116	12	92%
070116-06-v2.0.1	-	-	031	32:10.0	01:00.0	22	17	0	1	44	4	116	48%	0			11.2	19%	48.8	81%	60	81%	22	0	95%
070116-06-v2.0.1	-	-	032	33:10.0	01:00.0	110	93	1	10	43	8	119	46%	11	809	751	55.3	92%	4.7	8%	60	8%	110	11	91%
070116-06-v2.0.1	-	-	033	34:10.0	01:00.0	94	86	1	7	44	0	117	46%	14	1282	883	47.9	80%	12.1	20%	60	20%	94	14	93%
070116-06-v2.0.1	-	-	034	35:10.0	01:00.0	75	62	2	11	41	1	116	43%	16	1098	1309	38	63%	22	37%	60	37%	75	16	85%
070116-06-v2.0.1	-	-	035	36:10.0	01:00.0	108	67	2	39	38	6	114	44%	16	784	1072	57	95%	3	5%	60	5%	108	16	64%
070116-06-v2.0.1	-	-	036	37:10.0	01:00.0	42	19	0	19	35	9	118	44%	11	1183	1105	20.8	35%	39.2	65%	60	65%	42	11	55%
070116-06-v2.0.1	-	-	037	38:10.0	01:00.0	0					0			0			0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	038	39:10.0	01:00.0	0					0			0			0	0%	60	100%	60	100%	0	0	-
070116-06-v2.0.1	-	-	039	40:10.0	01:00.0	66	16	0	50	33	7	120	49%	0			33.2	55%	26.8	45%	60	45%	66	0	24%
070116-06-v2.0.1	-	-	040	41:10.0	01:00.0	107	10	0	97	31	26	120	51%	0			53.1	89%	6.9	12%	60	12%	107	0	9%
070116-06-v2.0.1	-	-	041	42:10.0	01:00.0	65	37	0	20	39	15	113	49%	0			34.1	57%	25.9	43%	60	43%	65	0	69%
070116-06-v2.0.1	-	-	042	43:10.0	01:00.0	112	37	0	74	34	19	112	49%	0			60	100%	0	0%	60	0%	112	0	34%
070116-06-v2.0.1	-	-	043	44:10.0	01:00.0	118	14	2	99	31	45	118	49%	0			60	100%	0	0%	60	0%	118	0	16%
070116-06-v2.0.1	-	-	044	45:10.0	01:00.0	86	5	1	72	30	38	120	47%	0			42.9	71%	17.1	29%	60	29%	86	0	16%
070116-06-v2.0.1	-	-	045	46:10.0	01:00.0	98	9	0	63	33	60	114	48%	0			50	83%	10	17%	60	17%	98	0	36%
070116-06-v2.0.1	-	-	046	47:10.0	01:00.0	111	11	1	97	28	41	117	49%	0			56.6	94%	3.4	6%	60	6%	111	0	13%
070116-06-v2.0.1	-	-	047	48:10.0	01:00.0	84	5	0	77	27	25	121	47%	0			40	67%	20	33%	60	33%	84	0	8%
070116-06-v2.0.1	-	-	048	49:10.0	01:00.0	111	7	6	91	33	63	115	50%	0			58.2	97%	1.8	3%	60	3%	111	0	18%
070116-06-v2.0.1	-	-	049	50:10.0	01:00.0	119	5	0	100	30	95	119	47%	0			58.8	98%	1.2	2%	60	2%	119	0	16%
070116-06-v2.0.1	-	-	050	51:10.0	01:00.0	105	7	3	88	30	67	112	47%	0			54.5	91%	5.5	9%	60	9%	105	0	16%
070116-06-v2.0.1	-	-	051	52:10.0	01:00.0	127	1	0	113	29	110	127	48%	0			58.9	98%	1.1	2%	60	2%	127	0	11%

Limitations of Device

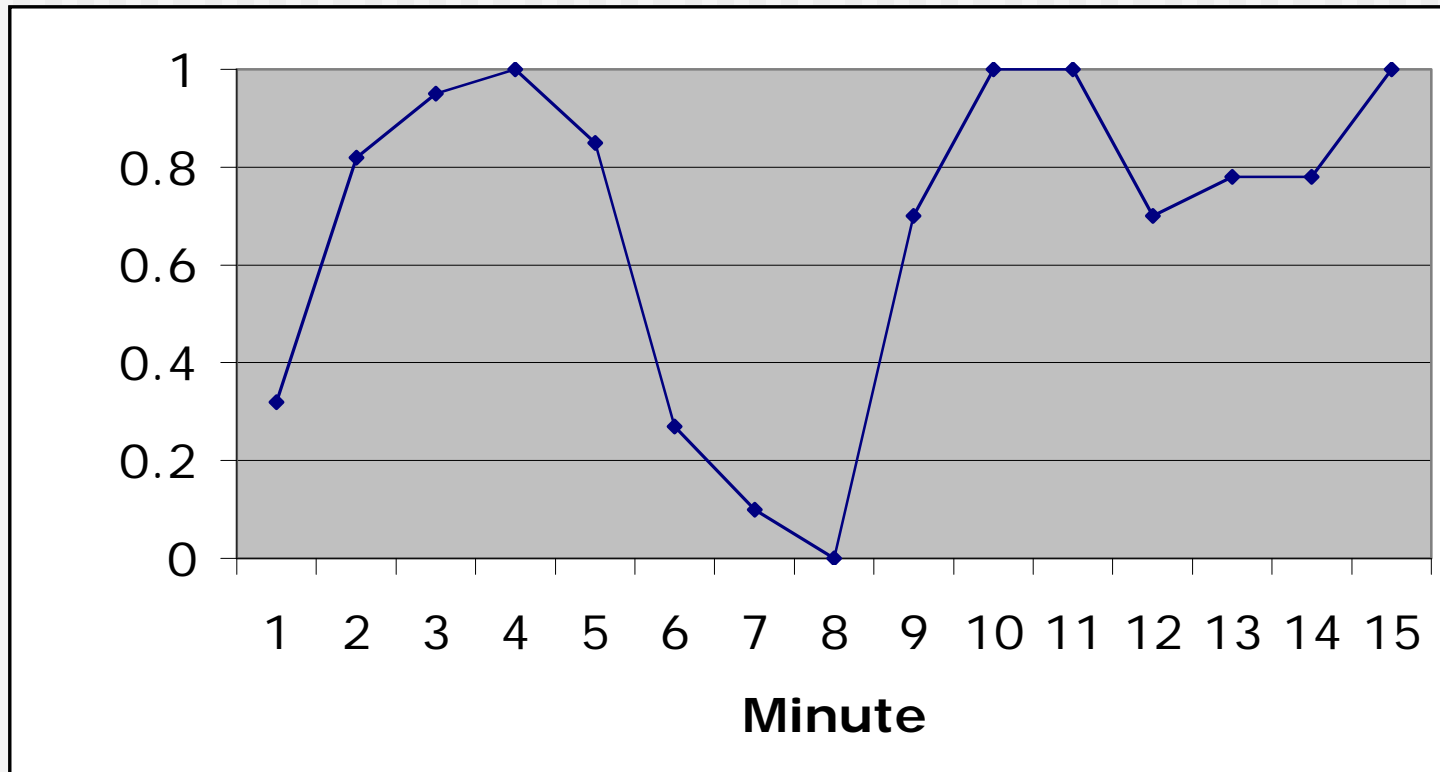


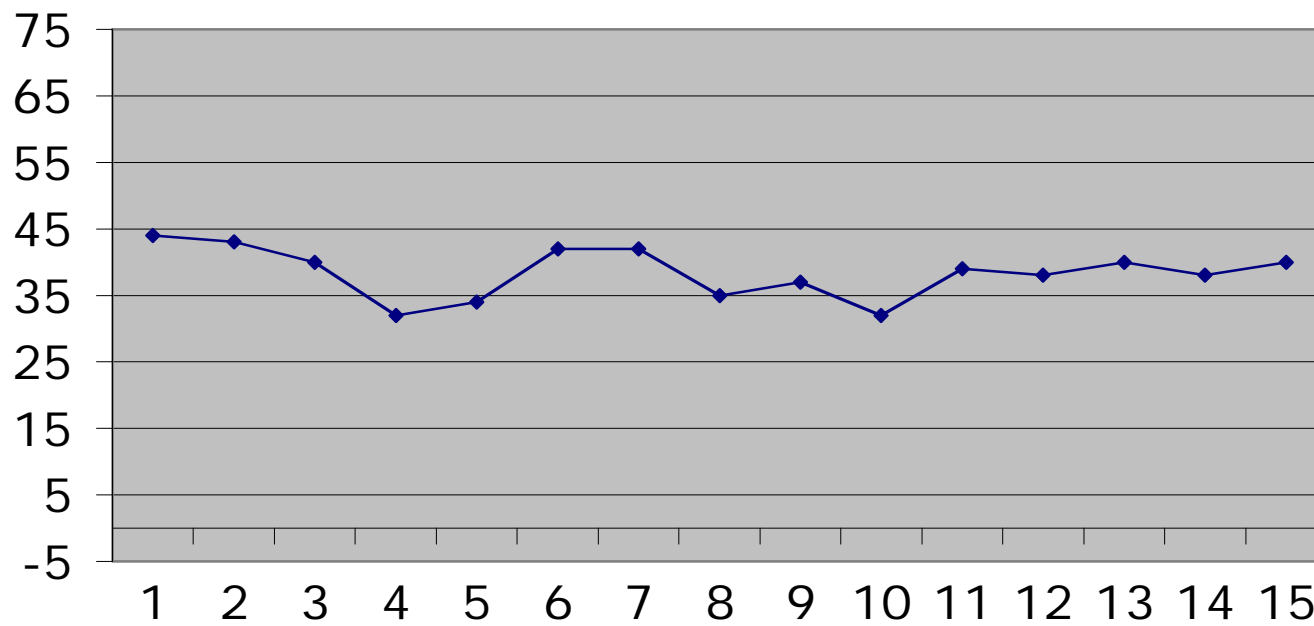
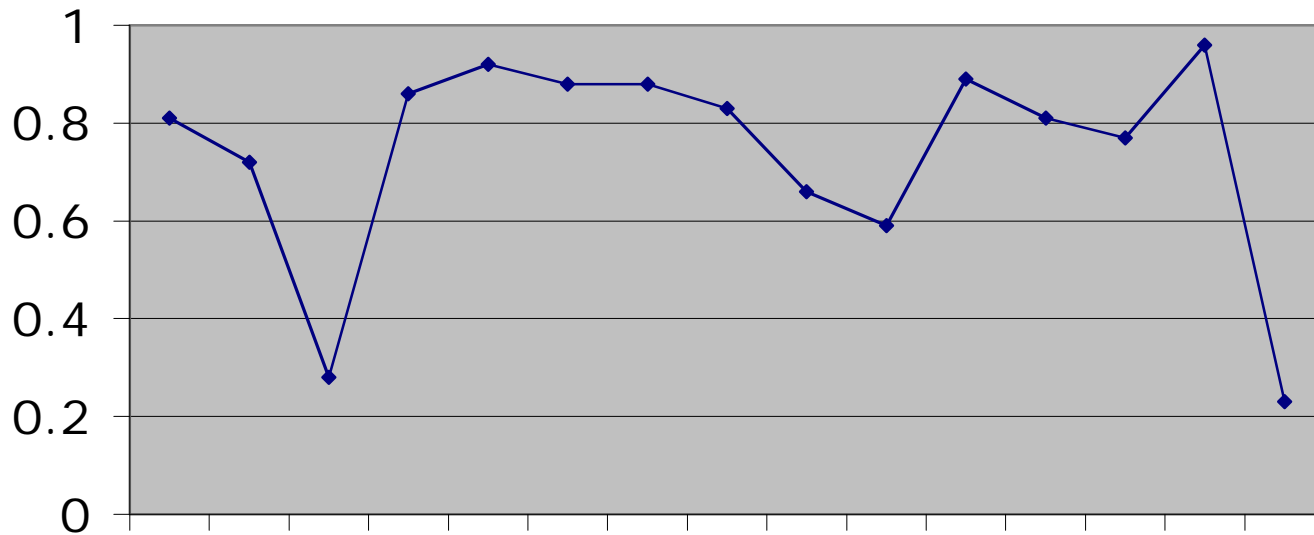
- Must be turned to Therapy Mode / AED
 - Monitor setting does not activate puck or feedback
- Puck must be placed
 - Especially when feedback is off, this is an extra step
- Mute button
 - Visual prompt and beeps are qualitatively different

Acceptance

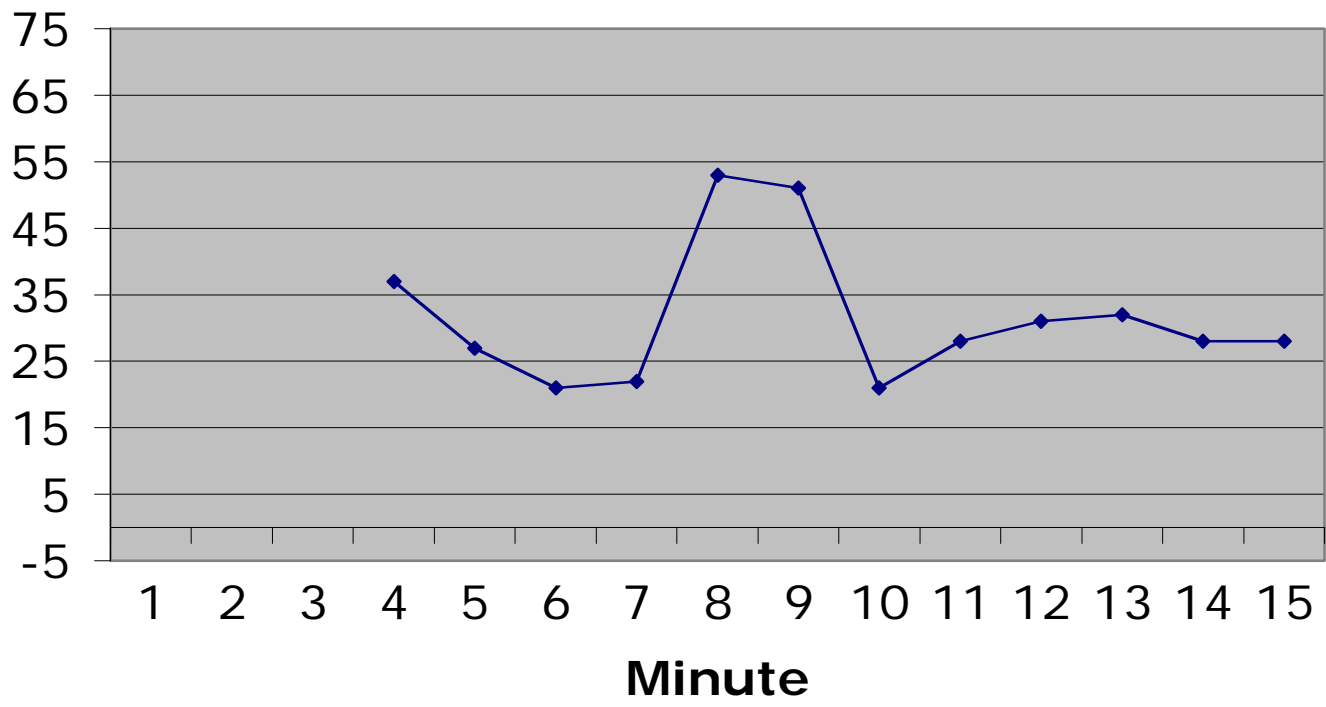
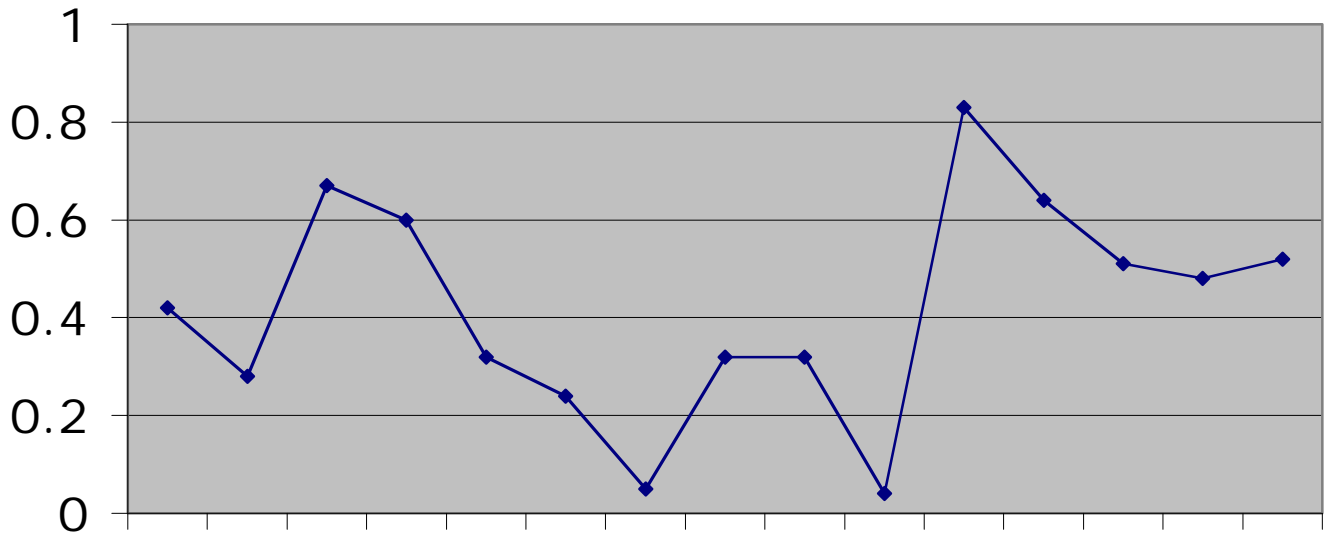
- Very Easy
 - No training beyond use of Philips monitors
- Modest requirement for provider compliance
 - Place puck (even when getting no feedback)
 - Avoid turning feedback off

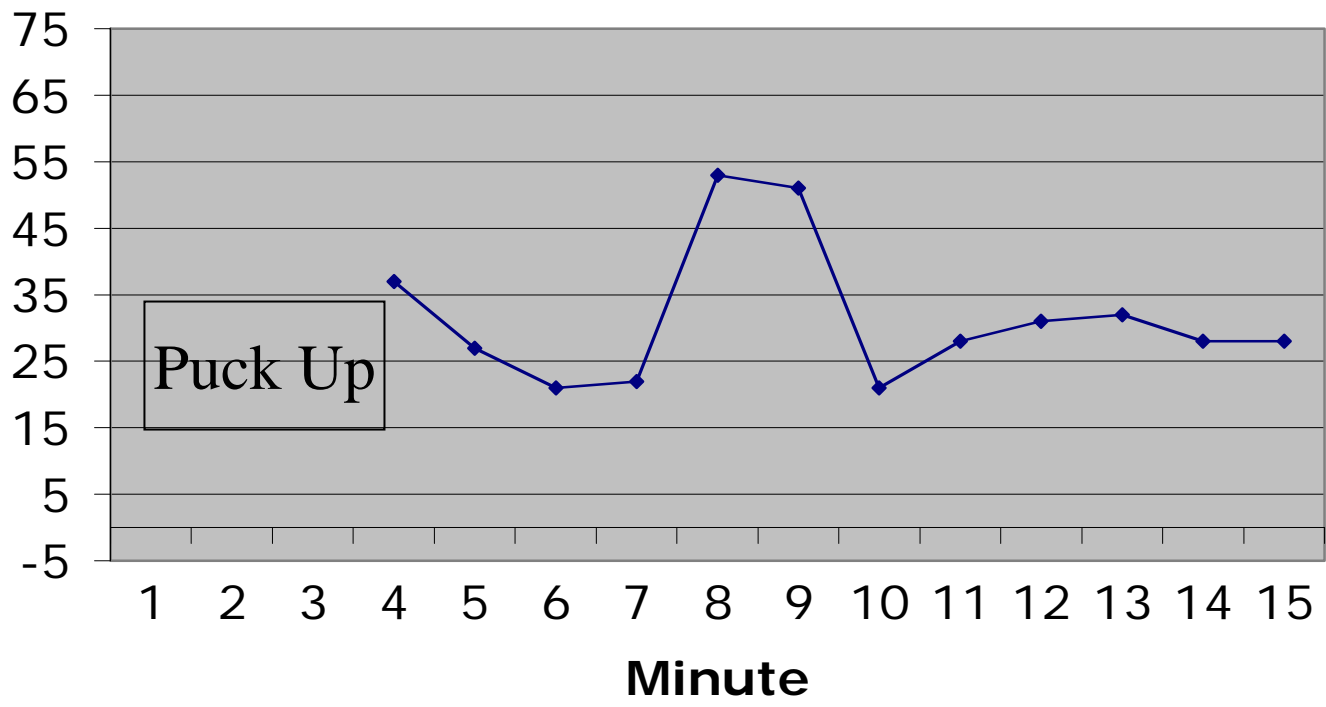
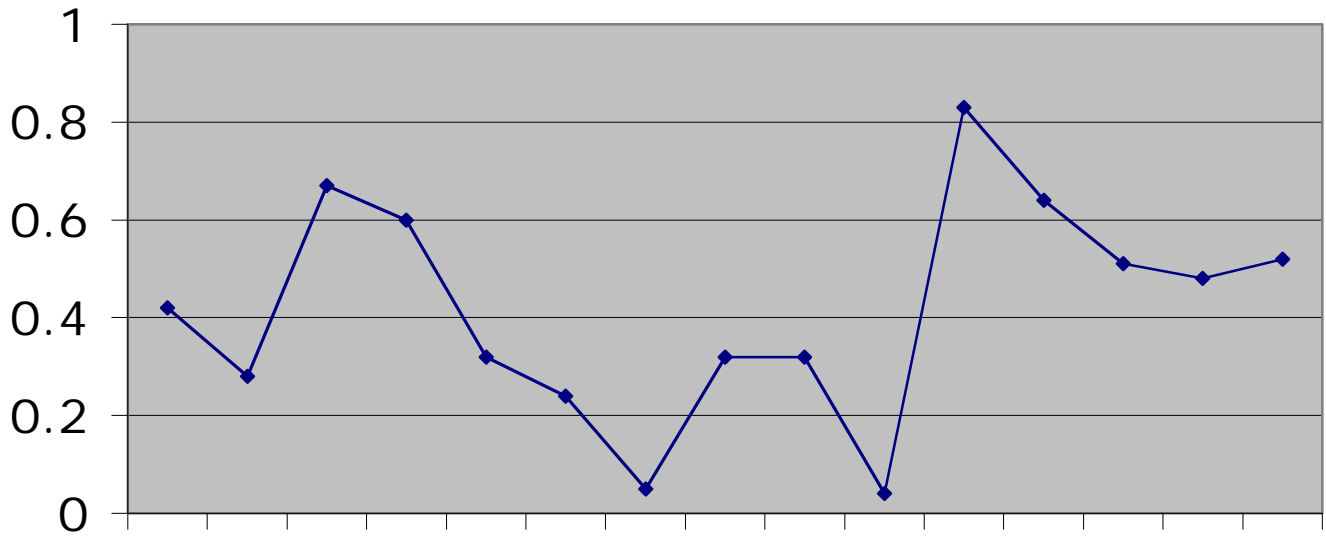
Individual Cases





Minute





Ongoing ROC Feedback Study

■ Inclusion Criteria

- Cardiac Arrest
 - Chest compressions by EMS
- Age \geq 18 years
- In “Epistry”

■ Limited to

- Philips monitors in place
- Voluntary participation not interfering with ROC-PRIMED
- Seattle - King County and Pittsburgh

Primary Hypothesis

- Automated, real-time feedback on CPR process variables will
 - (1) Improve compliance with CPR guidelines
 - CPR Fraction increased
 - Compression Depth more often in range.
 - Less incomplete release (“leaning on patient”).
 - (2) Increase the rate of return of spontaneous circulation.

Random Allocation

- Clusters randomized to “CPR feedback” or “no feedback.”
- Clusters cross over between intervention assignments.
- At cross-over, an administrator or researcher visits each monitor and flips switch to turn feedback on or off.

Data Collection

- Same as Epistry
 - Must retrieve digital data files
 - With honest effort, succeed in 70-80% of calls
 - Sometimes “puck”
 - Enter data for “optional” CPR process variables
 - Compression Depth
 - Incomplete Release
 - Ventilations

Regulatory

- Phillips Q-CPR feedback defibrillator devices are approved for use in cardiac arrest by FDA and Health Canada.
- Current feedback study in Seattle and Pittsburgh was deemed “Minimal Risk.”
 - No FDA
 - No public consultation / disclosure
 - No post-treatment notification for subjects

Conclusion

- Philips MRX is a powerful platform for reconstructing and measuring the performance of CPR
 - Already have data for QI
- This consortium will determine whether feedback improves compliance with guidelines
 - Remains to be seen if that helps patients!
- Some technical improvements would ease compliance with monitoring