Automatic tube compensation

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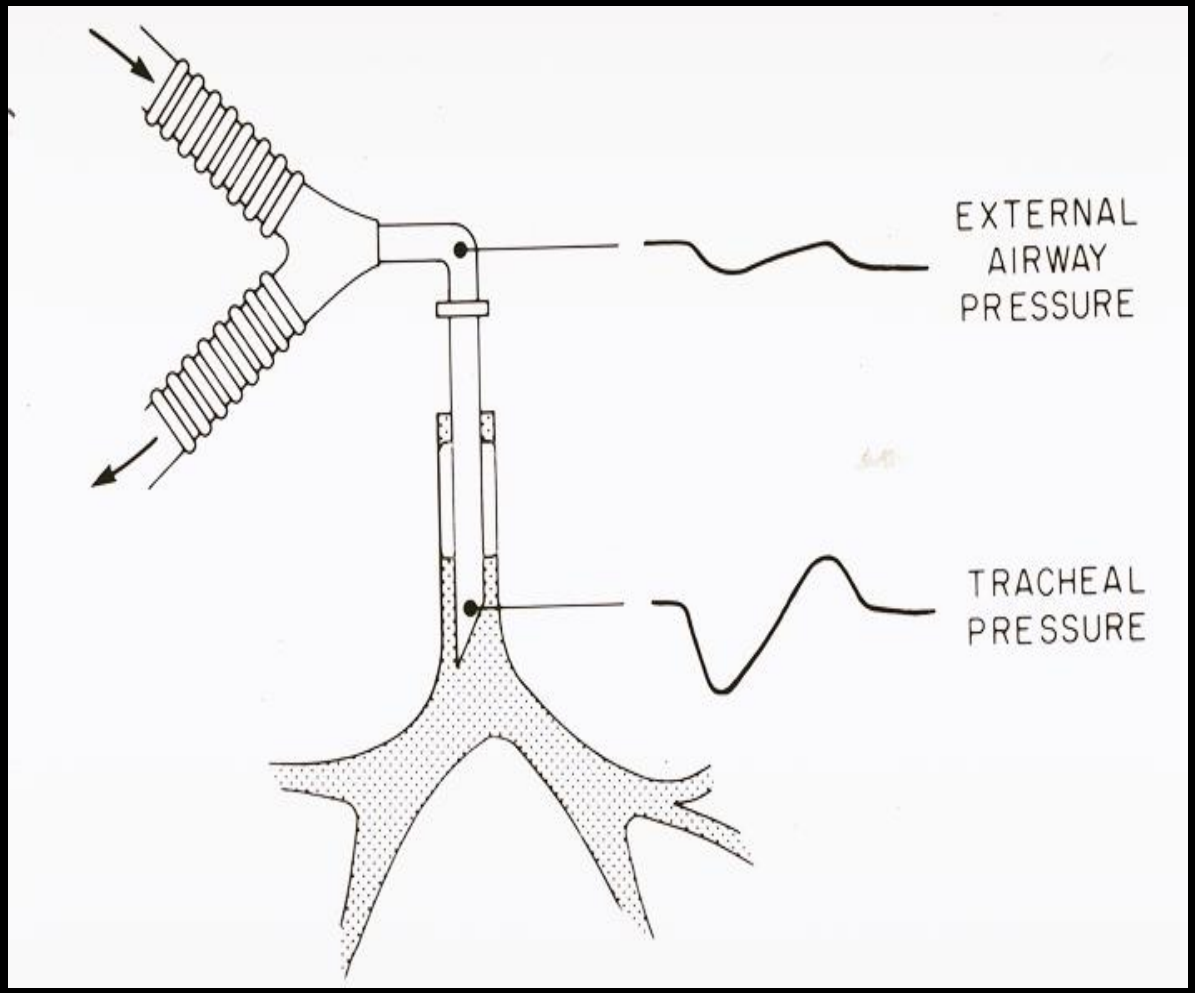
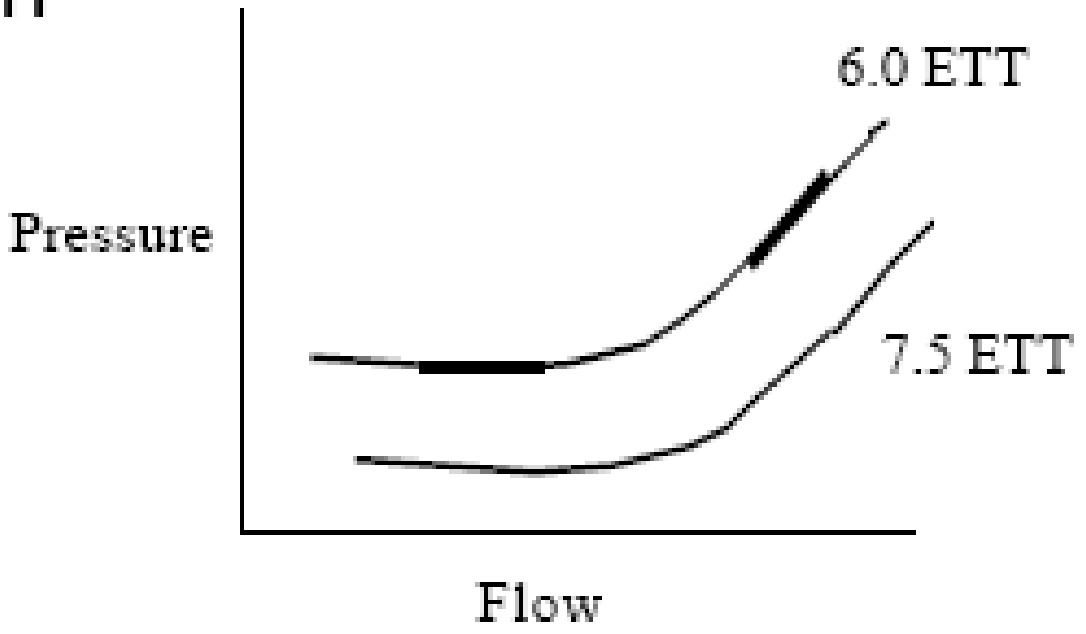
External and Tracheal Pressures Differ Because of Tube Resistance



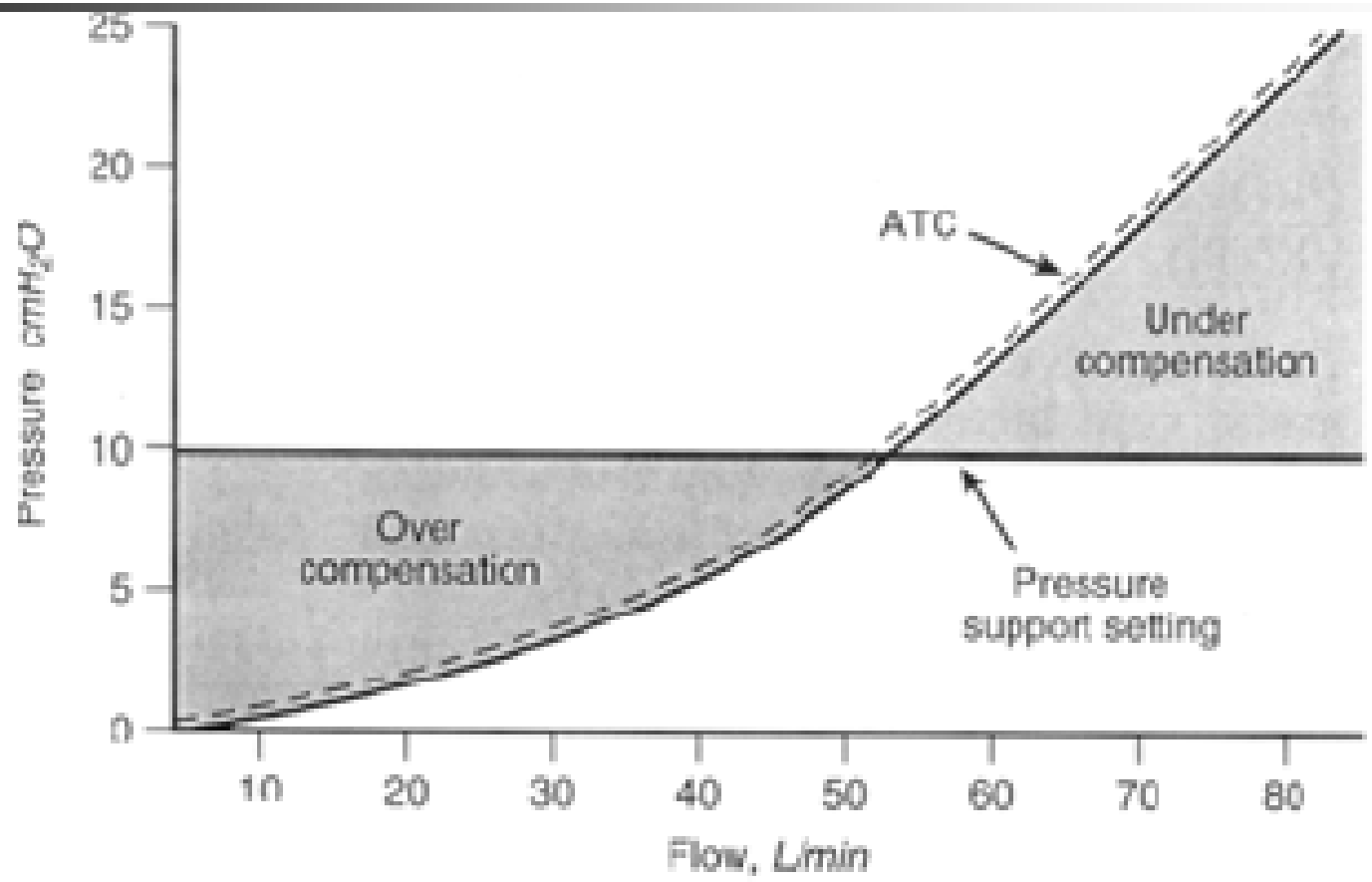
ATC offsets a fraction of tube resistance

Resistance Due To Endotracheal Tube

- Varies with
  - radius
  - length
  - flow



ATC vs. PSV for ET Tube Resistance



Automatic Tube Compensation

$$P_{vent} = abnormal\ \ resistive\ load = R_{tube} \times flow^2$$

operator sets tube diameter
ventilator calculates resistance factor

Automatic Tube compensation

- Pressure is applied and continuously adjusted proportional to resistance.
- Pvent (cm H2O) = Tracheal pressure (cm H2O) + tube coefficient (cm H2O /L/sec) * flow^2 (L/min)

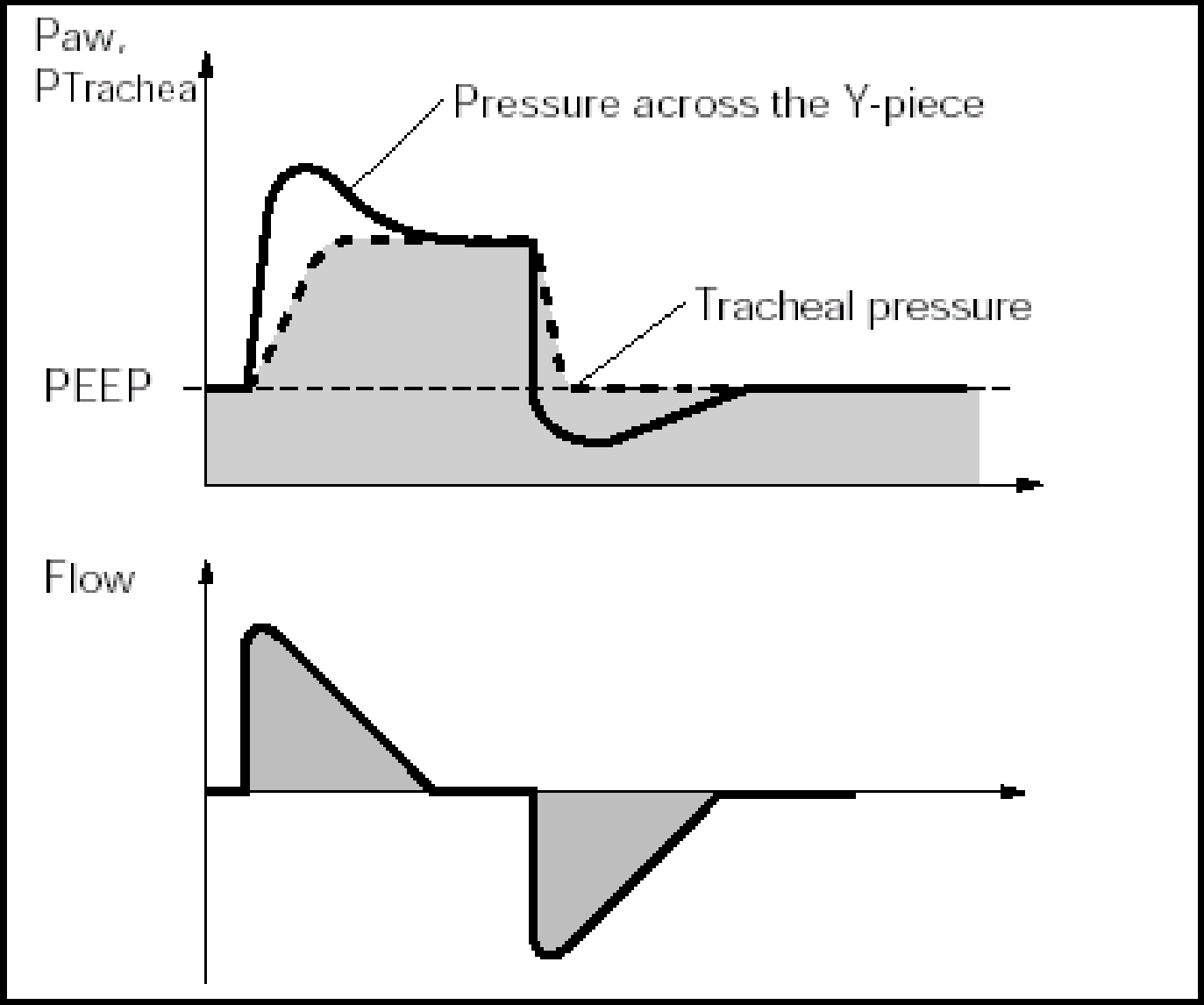
Table 3. Nonlinear Approximation Coefficients for Endotracheal and Tracheostomy Tubes of Different Size and Length (Ambient Conditions)

Specification 21 mm Trachea			Inspiration				Expiration			
Type Diameter (mm)	Status	Length (cm)	K1I ($cmH_2O \cdot s/L$)	K2I	rms (cmH_2O)	N*	K1E ($cmH_2O \cdot s/L$)	K2E	rms (cmH_2O)	N*
Mallinckrodt 107 intermediate										
7.0	Original	30.8	11.12	1.99	0.27	120	11.69	1.85	0.36	126
7.0	Cut	30.0	11.00	2.02	0.28	120	11.74	1.84	0.36	126
7.0	Cut	28.0	11.77	2.11	0.33	120	12.21	1.78	0.36	126
7.0	Cut	26.0	10.20	2.08	0.27	120	10.24	1.80	0.30	126
7.0	Cut	24.0	10.72	2.06	0.26	120	10.73	1.75	0.31	126
7.0	Cut	22.0	10.08	2.09	0.39	120	10.09	1.76	0.28	126
7.0	Cut	20.0	9.62	2.06	0.25	120	9.44	1.77	0.32	126
7.5	Original	31.2	8.41	1.96	0.21	121	9.28	1.81	0.31	125
7.5	Cut	30.0	8.52	1.98	0.32	121	9.19	1.77	0.24	125
7.5	Cut	28.0	8.35	2.01	0.31	121	8.45	1.77	0.28	125
7.5	Cut	26.0	7.87	2.03	0.21	121	7.92	1.79	0.30	125
7.5	Cut	24.0	7.86	1.95	0.26	121	7.63	1.77	0.30	125
7.5	Cut	22.0	7.20	1.98	0.23	121	7.11	1.79	0.27	125
7.5	Cut	20.0	7.35	2.01	0.25	122	6.88	1.76	0.24	124
8.0	Original	32.3	6.57	1.94	0.23	122	7.50	1.75	0.24	124
8.0	Cut	30.0	6.41	1.93	0.25	121	7.59	1.68	0.20	125
8.0	Cut	28.0	6.47	1.92	0.20	122	7.03	1.69	0.16	124
8.0	Cut	26.0	6.34	2.03	0.25	122	6.34	1.74	0.18	124
8.0	Cut	24.0	6.14	2.02	0.23	122	6.15	1.78	0.24	124
8.0	Cut	22.0	5.95	2.06	0.24	122	6.34	1.79	0.19	124
8.5	Original	32.7	5.17	1.94	0.20	122	5.12	1.88	0.28	124
8.5	Cut	30.0	4.83	1.96	0.19	122	5.48	1.71	0.19	124
8.5	Cut	28.0	4.69	1.97	0.19	122	5.30	1.79	0.17	124
8.5	Cut	26.0	4.97	2.00	0.18	123	4.78	1.72	0.14	123
8.5	Cut	24.0	4.88	2.01	0.19	123	4.50	1.74	0.19	123
8.5	Cut	22.0	4.64	1.99	0.18	123	4.49	1.79	0.17	123
9.0	Original	33.8	4.29	1.94	0.16	122	4.28	1.88	0.24	124
9.0	Cut	30.0	4.10	1.95	0.17	123	4.21	1.77	0.15	123
9.0	Cut	28.0	4.02	1.96	0.16	123	4.10	1.74	0.14	123
9.0	Cut	26.0	4.14	1.99	0.16	123	4.00	1.70	0.16	123
9.0	Cut	24.0	3.92	2.00	0.15	123	3.74	1.71	0.15	123
9.0	Cut	22.0	3.74	1.93	0.13	123	3.56	1.71	0.16	123
Mallinckrodt 122 hi-lo jet										
7.0	Original	30.5	10.59	2.03	0.29	119	11.25	1.82	0.45	127
8.0	Original	32.0	5.84	1.89	0.19	123	5.74	1.77	0.17	123
9.0	Original	32.0	3.85	1.90	0.14	123	3.79	1.78	0.18	123
Mallinckrodt 100 hi-lo tracheostomy										
8.0	Original	9.0	4.50	2.03	0.14	125	3.70	1.74	0.12	120
9.0	Original	10.0	2.95	2.00	0.10	124	2.24	1.79	0.15	121
10.0	Original	10.5	2.05	1.98	0.06	125	1.77	1.82	0.11	121

rms = root-mean-square deviation.

* Number of analyzed samples.

Automatic tube compensation



Automatic Tube Compensation

- The endotracheal tube offers resistance to ventilation both on inspiration and on expiration.
- A low level of pressure support can help overcome this pressure cost, but its effect varies with flow rate.
- Automatic tube compensation (ATC) adjusts its pressure output in accordance with flow, theoretically giving an appropriate amount of pressure support as needed as the cycle proceeds and flow demands vary within and between subsequent breaths.
- Some variants of ATC drop airway pressure in the early portion of expiration to help speed expiration.
- Supplemental pressure support can be provided to assist in tidal breath delivery