Clinical Workshop

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Cardiovascular Responses to Laryngoscopy and Endotracheal Intubation with Pancuronium during Light General Anesthesia

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Pancuronium bromide, a new nondepolarizing neuromuscular blocking agent, has been reported to produce tachycardia in anesthetized man in a dose of 0.07 mg/kg.[1] This drug has also been found suitable for endotracheal intubation in a dose range of 0.08 to 0.16 mg/kg.[2,3] However, the combination of light anesthesia and pancuronium during intubation could potentially lead to hazardous complications, namely hypertension or cardiac arrhythmias.

This study was designed to ascertain among different age groups the circulatory effects of laryngoscopy, lidocaine 4 per cent spray, and endotracheal intubation with pancuronium in a dose of 0.1 mg/kg. Measurements were made at two times, 3 minutes (early) and 5 minutes (late) after intubation.

METHOD

Subjects of the study were 111 adult patients, 55 men and 56 women, all of whom showed no evidence of cardiac or pulmonary disease, undergoing a variety of elective surgical procedures. Informed consent was obtained from each patient on the evening prior to operation. All patients were premedicated with morphine, 6–15 mg, and scopolamine, 0.4 mg, about 90 minutes before the start of anesthesia. An infusion of dextrose, 5 per cent in Ringer's lactate solution, was begun, and control values for systolic and diastolic pressures (Riva Rocci method), pulse rate, and lead 2 of the electrocardiogram were obtained. Anesthesia was induced with thiopental, 25 to 50 mg, every 15 seconds until the lid reflex disappeared. At this time an oropharyngeal airway was inserted and administration of nitrous oxide–oxygen 6–3 l/min was started through a tight-fitting face mask. Additional increments of thiopental, 25 to 50 mg, were injected when a patient showed signs of awakening.

When the arterial pressure had attained a steady state following any change caused by thiopental, pancuronium, 0.1 mg/kg was injected as a single bolus intravenously. Nitrous oxide–oxygen 4–2 l/min was continued, with ventilation being manually assisted or controlled. Three or 5 minutes after pancuronium administration, laryngoscopy, tracheal spray with 4 per cent lidocaine, 3 ml/70 kg, and endotracheal intubation were performed. Following intubation, ventilation was controlled with an Air Shields ventilator. Systolic and diastolic pressures and pulse rates before and after the injection of thiopental and each minute for ten consecutive minutes after pancuronium were measured. After this 10-minute period of recording, preparation for operation was allowed to commence.

Changes in pulse and systolic and diastolic blood pressures 1) from immediately before to immediately after intubation and 2) from immediately after intubation to 4 minutes later

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TABLE 1. Changes of Pulse Rate, Systolic and Diastolic Blood Pressure, Intubation Time 3 Minutes after Pancuronium in 41 Anesthetized Adult Patients

Condition	Pulse Rate	Blood Pressure: Systolic	Blood Pressure: Diastolic
2–3 minutes after thiopental	98.0 ± 3.2*	93.5 ± 2.0*	96.4 ± 3.0*
Pancuronium given			
1 minute	104.7 ± 5.1	94.8 ± 2.6	97.7 ± 2.1
2 minutes	106.0 ± 4.9	94.6 ± 2.1	98.3 ± 2.2
3 minutes	107.1 ± 3.6	94.7 ± 3.0	97.3 ± 2.3
Intubation			
4 minutes	117.5 ± 7.4	117.1 ± 2.7	115.2 ± 3.6
5 minutes	116.3 ± 6.3	113.0 ± 3.7	112.7 ± 3.6
6 minutes	112.3 ± 5.6	109.2 ± 3.2	106.2 ± 2.8
7 minutes	109.7 ± 5.7	105.4 ± 2.8	103.6 ± 3.1
8 minutes	106.9 ± 6.0	100.5 ± 2.4	101.8 ± 2.6
9 minutes	105.0 ± 3.0	99.0 ± 2.8	100.4 ± 2.2
10 minutes	105.0 ± 2.1	98.8 ± 3.0	100.5 ± 2.7

* Mean ± SEM expressed as per cent of control value.

TABLE 2. Changes of Pulse Rate, Systolic and Diastolic Blood Pressure, Intubation Time 5 Minutes after Pancuronium in 70 Anesthetized Adult Patients

Condition	Pulse Rate	Blood Pressure: Systolic	Blood Pressure: Diastolic
2–3 minutes after thiopental	98.2 ± 7.0*	96.6 ± 3.0*	97.0 ± 4.0*
Pancuronium given			
1 minute	103.3 ± 7.4	96.6 ± 3.4	98.1 ± 3.2
2 minutes	105.1 ± 6.3	95.9 ± 2.8	98.5 ± 4.1
3 minutes	105.6 ± 5.4	94.6 ± 3.0	99.3 ± 3.4
4 minutes	105.7 ± 5.9	93.8 ± 2.5	99.5 ± 3.7
5 minutes	106.0 ± 6.2	93.6 ± 3.6	99.5 ± 3.7
Intubation			
6 minutes	114.4 ± 5.7	111.2 ± 4.0	107.7 ± 3.4
7 minutes	113.4 ± 7.3	109.6 ± 2.7	104.8 ± 3.9
8 minutes	110.6 ± 6.3	104.5 ± 3.1	101.5 ± 3.1
9 minutes	105.8 ± 5.9	99.4 ± 3.6	98.9 ± 3.5
10 minutes	103.4 ± 4.8	98.6 ± 3.2	98.7 ± 3.9

* Mean ± SEM expressed as per cent of control value.

for five age groups were evaluated. The changes were measured 1) as the difference between the actual measurements and 2) as the logarithms of the ratios of the actual measurements. The latter assessment showed less variance heterogeneity, as judged by Bartlett's M-Test, than the difference between the actual measurements. However, the results of the analyses were essentially the same for both variables, so that only the ones showing differences are presented here.

Tables 3 to 5 give the means (M) and standard deviation (SD) of the pre-pancuronium readings, the differences between the post- and preintubation readings, and the differences between the readings 4 minutes after and immediately after intubation (labeled "End/postintubation") for each intubation

TABLE 3. Pulse (Beats/Min) Values: Means (M), Standard Deviations (SD), and Sample Sizes

	Age (Years)	Intubation Time	Number		Variable: Pre-pancuronium	Variable: Post-/preintubation	Variable: End/postintubation
Group I	M 30.3	3 min	9	M	87.8	10.0	−2.9
	SD 6.6			SD	16.6	9.6	10.5
		5 min	10	M	78.6	−3.8	−14.4
				SD	6.0	6.2	12.4
Group II	M 45.2	3 min	8	M	86.0	13.0	−12.8
	SD 2.8			SD	23.2	10.6	5.7
		5 min	9	M	82.0	8.2	−14.9
				SD	14.2	13.5	11.9
Group III	M 54.0	3 min	6	M	80.7	5.0	−10.7
	SD 3.1			SD	5.3	5.6	8.5
		5 min	15	M	77.2	2.7	−3.1
				SD	14.6	4.3	4.4
Group IV	M 64.6	3 min	8	M	82.5 −	1.8	−5.5
	SD 2.7			SD	8.5	4.7	5.7
		5 min	22	M	73.8	9.2	−8.3
				SD	8.0	11.9	9.7
Group V	M 76.9	3 min	10	M	76.4	13.6	−12.2
	SD 5.0			SD	12.6	8.3	11.9
		5 min	14	M	74.6	3.0	−4.1
				SD	9.7	3.9	5.8

time and age group (differences are later value minus earlier value).

RESULTS

The patients were arbitrarily divided into Groups I through V by age. For this study the mean age with standard deviation for each group is as presented in Table 3.

Before Intubation. Pulse rates increased after administration of pancuronium in all 111 subjects, but the increase was not statistically significant (tables 1 and 2).

Systolic and diastolic blood pressures likewise did not change significantly in the 3 to 5 minutes after the administration of pancuronium (tables 1 and 2).

"Post/preintubation" Variable. Heart rate values were higher at 3 minutes (early) than at 5 minutes (late) after administration of pancuronium. This difference between intubation times was significant at $P < .01$ (table 3). There was also a significant variation in pulse rates among different age groups ($P < .05$), but no reasonably consistent trend was discernible (table 3). There was significant variation ($P < .01$) in the effects of intubation times among different age groups (joint effect); however, no clinically meaningful trend of that relationship can be discerned from this study. One cannot state that intubation at 3 minutes *vs.* 5 minutes would be preferable in one age group *vs.* any other age group so far as pulse rate is concerned.

There were significant differences ($P < .05$) between systolic blood pressure changes at 3-minute and 5-minute intubation times and among changes in different age groups ($P < .05$), but the joint effect of intubation time and age was no longer significant (table 4).

For diastolic blood pressure, there were significant differences ($P < .01$) between intubation at 3 minutes and at 5 minutes after pancuronium administration, in that the ear-

TABLE 4. Systolic Blood Pressure (mm Hg) Values: Means (M), Standard Deviations (SD), and Sample Sizes

	Intubation Time	Number		Variable: Pre-pancuronium	Variable: Post-pre-intubation	Variable: End/post-intubation
Group I	3 min	10	M	112.5	21.0	−14.5
			SD	14.8	16.1	9.0
	5 min	9	M	119.4	20.0	−15.6
			SD	18.1	12.0	9.8
Group II	3 min	8	M	116.3	28.1	−21.9
			SD	13.0	18.1	20.0
	5 min	9	M	117.8	26.1	−22.8
			SD	14.8	20.7	20.2
Group III	3 min	6	M	123.3	15.8	−15.8
			SD	37.2	13.6	18.6
	5 min	15	M	127.0	20.3	−11.7
			SD	29.7	18.9	16.5
Group IV	3 min	8	M	121.3	36.3	−28.8
			SD	24.2	13.3	16.4
	5 min	23	M	142.4	28.7	−21.3
			SD	27.9	17.7	16.3
Group V	3 min	13	M	130.0	44.2	−26.5
			SD	20.0	22.0	16.8
	5 min	11	M	123.6	19.5	−11.4
			SD	26.3	6.9	13.1

lier intubation produced a greater increase in diastolic pressure (table 5). There was no difference among age groups in this increase, nor was there any significant joint effect of intubation time with age group.

"End/postintubation" Variable. The only significant differences ($P < .01$) found in this variable were to be seen in the pulse rates, where the joint effects of intubation time with age were considered (table 3). No clinically relevant trend of that relationship can be discerned from this study.

In summary, although there is an identifiable difference between the joint effect of intubation time and age in the pulse rate changes, the only circulatory criterion of concern so far as suggesting the later intubation time (5 minutes) over the earlier one is the greater rise in diastolic blood pressure with the earlier intubation. This diminished rise in diastolic blood pressure with intubation at 5 minutes was not at all dependent upon age (table 5).

Of particular interest with all circulatory criteria studied at both early and late intubation was the prompt return (within 4 minutes after intubation) of all values back toward control (pre-pancuronium) levels (tables 1 and 2). This finding suggests the prompt onset of topical analgesia with lidocaine, 4 per cent, and the re-establishment of the partial pressure of nitrous oxide with resumption of controlled ventilation.

Discussion

Several authors have reported slight to moderate increases in pulse rate in lightly anesthetized man after pancuronium administration.[1,3,4,5] Our results reveal no significant change in pulse rate in the first 5 minutes after pancuronium, 0.1 mg/kg. Variations in blood pressure after pancuronium in our study are consonant with previous work[1,3,4,5] revealing no significant change.

DeVault *et al.*[6] carefully studied the effects of intubation on cardiac hemodynamics. They

TABLE 5. Diastolic Blood Pressure (mm Hg) Values: Means (M), Standard Deviations (SD), and Sample Sizes

	Intubation Time	Number		Variable: Pre-pancuronium	Variable: Post-/pre-intubation	Variable: End/post-intubation
Group I	3 min	10	M	68.0	15.0	−11.5
			SD	11.1	15.6	14.2
	5 min	9	M	76.7	6.1	−7.8
			SD	12.2	7.0	6.2
Group II	3 min	8	M	76.3	15.6	−11.9
			SD	10.6	7.3	9.2
	5 min	9	M	75.0	11.1	−10.6
			SD	7.9	8.2	8.1
Group III	3 min	6	M	72.5	10.0	−6.7
			SD	16.0	8.9	10.3
	5 min	15	M	77.0	8.3	−7.0
			SD	13.6	7.5	9.2
Group IV	3 min	8	M	71.3	15.6	−13.1
			SD	11.3	12.9	10.3
	5 min	23	M	85.0	12.6	−9.3
			SD	14.5	11.7	10.0
Group V	3 min	13	M	72.3	19.2	−15.4
			SD	9.3	11.9	11.3
	5 min	11	M	72.3	10.9	−9.5
			SD	10.8	9.7	10.1

found consistent increases in heart rate and systolic and diastolic blood pressures in 26 patients whose tracheas were intubated under light general anesthesia with succinylcholine. King and co-workers[7] suggested that these circulatory changes with intubation are probably the result of a sympathicoadrenal discharge rather than a "vago-vagal" phenomenon.

Harrison[3] and Levin,[5] using pancuronium for intubation, both observed increases in the values of circulatory variables in lightly anesthetized subjects. Harrison found a mean rise of 25 per cent in mean pressure following intubation, while Levin did not identify the percentage increase.

We found identifiable increases in pulse rates and systolic blood pressures after intubation with pancuronium at two intubation times. On the basis of these two circulatory criteria, one could not state that intubation at 5 minutes would be preferable to intubation at 3 minutes. However, our finding of greater increases in diastolic pressures in all age groups with the earlier intubation time would suggest caution with this technique in patients with known or suspected hypertensive disease.

Stoelting[8] reported premature ventricular contractions in two of four patients receiving only pancuronium for intubation. Dobkin *et al.*[9] also found transient ventricular arrhythmias in five patients receiving pancuronium only and in four patients who received only succinylcholine for intubation. In all our patients, no alteration in lead 2 occurred during or just after the injection of pancuronium, aside from an occasional slight increase in heart rate. Transient supraventricular arrhythmias—nodal or atrial premature contractions—were observed during intubation in 14 (12.5 per cent) of our patients. We were not able to discern a relationship between age or time of intubation and the incidence of arrhythmias. Although these arrhythmias are of physiologic interest, we agree with Katz[10] that they have minimal clinical significance. However, two of our patients had very brief runs of premature ventricular contractions during intubation. These were the only ventricular arrhythmias encountered, and were present only during instrumentation. They disappeared immediately after intubation without treatment. We do not believe that increased ventricular irritability due to pancuronium should be inferred.

The cardiovascular stability and ease of intubation with pancuronium in a dose of 0.1 mg/kg seems to commend its use for intubation and subsequent relaxation using light general anesthesia. The return of all cardiovascular variables back toward pre-pancuronium values within 4 minutes after endotracheal intubation preceded by spray with lidocaine, 4 per cent, speaks for the usefulness of this adjuvant in anesthetic techniques where potent inhalation anesthetics are not being utilized. Since none of our patients was hypertensive by history, nor were they being treated with antihypertensive medications, no generalization of our technique to the general population including hypertensive patients is warranted.

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A New Transducer and Holder for Recording Thumb Adduction

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Most clinical studies of the effects of neuromuscular blockers include recordings of thumb adduction to monitor the extent or type of neuromuscular block. To facilitate this measurement, a new transducer holder has been devised. The transducer and load cell are available commercially. The holder is manufactured by a local machine shop.

The components of the transducer and holder are shown in figure 1. The transducer is a Statham† universal transducing cell, model U C 2, with a Statham load cell accessory (UL4–10). The load cell accessory is attached to the transducing cell by threaded fittings which are integral parts of both components. These are mounted in a locally manufactured machined aluminum mounting costing about

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† Both are available from: Statham Laboratories Inc., P.O. Box 1178, HatoRey, Puerto Rico 00919.