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RAPLON™ (rapacuronium bromide) for Injection

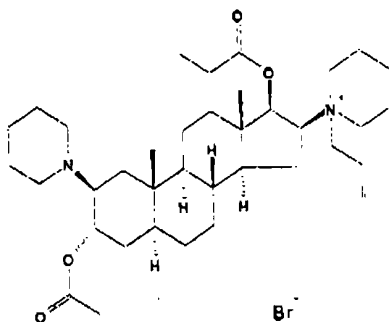
THIS DRUG SHOULD BE ADMINISTERED BY ADEQUATELY TRAINED INDIVIDUALS
FAMILIAR WITH ITS ACTIONS, CHARACTERISTICS AND HAZARDS.



DESCRIPTION

RAPLON™ (rapacuronium bromide) for Injection is a nondepolarizing neuromuscular blocking agent. Its chemical name is 1-[(2β,3α,5α,16β,17β)-3-(Acetyloxy)-17-(1-oxopropoxy)-2-(1-piperidiny)androstan-16-yl]-1-(2-propenyl) piperidinium bromide. The chemical formula of the bromide salt is $C_{37}H_{61}BrN_2O_4$ with a molecular weight of 677.78.

The structural formula is:



RAPLON™ is a synthetic steroid molecule with a mono-quaternary structure in the form of a bromide salt. This chemical structure has a basic steroid framework similar to other neuromuscular blocking agents like vecuronium, pancuronium, rocuronium, and pipecuronium. Rapacuronium bromide is distinguished as being a propenyl bromide ammonium salt with a 17-hydroxy propionate carboxyester that has the same basic steroid backbone as the rest of the family of steroid neuromuscular blockers.

RAPLON™ is supplied as a sterile, nonpyrogenic lyophilized cake in 5-mL and 10-mL vials. Each 5-mL vial contains 100 mg of rapacuronium bromide base, 35.8 mg of citric acid anhydrous, 7.5 mg of sodium phosphate dibasic anhydrous, 137.5 mg of mannitol, and sodium hydroxide and/or phosphoric acid to buffer and adjust the pH. When the 5-mL vial is reconstituted to a volume of 5 mL with sterile water for injection or bacteriostatic water for injection, an isotonic preparation for intravenous injection is obtained at a pH of 4.0 with a concentration of 20 mg of rapacuronium bromide base per mL. Each 10-mL vial contains 200 mg of rapacuronium bromide base, 71.5 mg of citric acid anhydrous, 15.0 mg of sodium phosphate dibasic anhydrous, 275.0 mg of mannitol, and sodium hydroxide and/or phosphoric acid to buffer and adjust the pH. When the 10-mL vial is reconstituted to a volume of 10 mL with sterile water for injection or bacteriostatic water for injection, an isotonic preparation for intravenous injection is obtained at a pH of 4.0 with a concentration of 20 mg of rapacuronium bromide base per mL.

40 **CLINICAL PHARMACOLOGY**

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 42 RAPLON™ (rapacuronium bromide) for Injection is a nondepolarizing neuromuscular blocking
 43 agent with a rapid onset of action (mean onset approximately 90 seconds; range 35-219
 44 seconds) and a dose-dependent duration of action. The recommended dose of 1.5 mg/kg in
 45 adults has a short clinical duration of action (mean duration approximately 15 minutes; range 6-
 46 30 minutes) (see CLINICAL PHARMACOLOGY-Clinical Studies). Rapacuronium acts by
 47 competing for cholinergic receptors at the motor end plate. Profound neuromuscular blockade
 48 induced by RAPLON™ can be reversed by neostigmine (see CLINICAL PHARMACOLOGY-Early
 49 Reversal).

50
 51 **Pharmacodynamics**

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 53 The neuromuscular block seen after the intravenous administration of 1.5 mg/kg RAPLON™
 54 (rapacuronium bromide) for Injection is primarily due to rapacuronium. Plasma levels of the major
 55 active metabolite of rapacuronium (the 3-hydroxy metabolite) are relatively low compared to the
 56 parent at a dose of 1.5 mg/kg of RAPLON™. Pharmacokinetic and pharmacodynamic modeling
 57 studies were conducted after the separate administration of rapacuronium bromide and the 3-
 58 hydroxy metabolite. These studies evaluated the effect of plasma drug concentrations on the
 59 neuromuscular block achieved as measured by mechanomyography of the adductor pollicis
 60 muscle to indirect supramaximal train-of-four stimulation of the ulnar nerve. These results are
 61 shown in Tables 1 and 2. Comparison of k_{eo} (rate constant for the equilibration between effect
 62 compartment and the outside effect compartment) and EC_{50} (concentration in the effect
 63 compartment at 50% drug effect) values of rapacuronium and the 3-hydroxy metabolite shows
 64 that the metabolite has slower onset and a higher potency than rapacuronium bromide. However,
 65 when comparing the ED_{90} (dose required to produce 90% suppression of the first $[T_1]$
 66 mechanomyographic [MMG] response of the adductor pollicis muscle to indirect supramaximal
 67 train-of-four stimulation of the ulnar nerve) of rapacuronium bromide (1.03 mg/kg) and the 3-
 68 hydroxy metabolite (0.42 mg/kg) with the ED_{90} of rocuronium (0.3 mg/kg), vecuronium (0.05
 69 mg/kg) and pancuronium (0.06 mg/kg), rapacuronium bromide and the 3-hydroxy metabolite may
 70 be viewed as low potency neuromuscular blocking drugs.

71
 72 TABLE 1: Pharmacokinetic/pharmacodynamic modeling parameters of rapacuronium bromide after a slow
 73 intravenous infusion of rapacuronium bromide in ten subjects at a median dose of 0.93 mg/kg over a
 74 median time of four minutes and forty seconds (mean (%CV)).

Parameter	
k_{eo} , 1/minute	0.44 (41)
γ	2.97 (23)
EC_{50} , mcg/mL	4.44 (33)
ED_{90} , mg/kg	1.03 (33)

75
 76 TABLE 2: Pharmacokinetic/pharmacodynamic modeling parameters of the 3-hydroxy metabolite after a
 77 slow intravenous infusion in seven subjects of a median dose of 0.68 mg/kg over three to five minutes
 78 (mean (%CV)).

Parameter	
k_{eo} , 1/minute	0.10 (40)
γ	4.83 (44)
EC_{50} , mcg/mL	2.06 (55)
ED_{90} , mg/kg	0.46 (33)

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 80 The ED_{50} for rapacuronium bromide (dose required to produce 50% suppression of the first $[T_1]$
 81 mechanomyographic [MMG] response of the adductor pollicis muscle to indirect supramaximal
 82 train-of-four stimulation of the ulnar nerve) during opioid/nitrous oxide/oxygen anesthesia is
 83 approximately 0.3 mg/kg in adult (18 to 64 years) and geriatric (≥ 65 years) patients. The ED_{50} for

84 rapacuronium bromide for pediatric patients (1 to 12 years) is 0.4 mg/kg and for infants (1 month
85 to < 1 year) is 0.3 mg/kg (see PRECAUTIONS, Pediatric Use).

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87 Tables 3 and 4 present the neuromuscular function parameters following an initial dose of
88 RAPLON™ in adult patients (18 to 64 years) and geriatric patients (≥ 65 years).

89
90 TABLE 3: Neuromuscular Function Parameters (Mean (SD)) Following an Initial Dose of RAPLON™ in
91 Adults (18 to 64 years)

Dosage	Time to Maximum Block ^a (sec)	Maximum Block ^b (%)	Clinical Duration (min) ^c	25%-75%T ₁ Recovery Index (min)	Time to 70% T ₄ /T ₁ recovery ^d (min)
RAPLON™ 1.5 mg/kg	88 (47) (n=32)	99 (2) (n=49)	15 (5) (n=57)	9 (5) (n=38)	34 (15) (n=47)

92 a= time from injection to maximum block (peak effect)

93 b= (100 - % T₁ control at peak effect)

94 c= time from injection to return to 25% of control T₁

95 d= time from injection to recovery of 70% T₄/T₁

96
97 In U.S. clinical trials, in adult patients (18 to 64 years), the mean (SD) time to maximum block [time
98 from injection to maximum block (peak effect)] following an initial 2.5 mg/kg dose of
99 RAPLON™ was 72 (24) seconds (n=19). The mean (SD) clinical duration (time from injection to
100 return to 25% of control T₁), in adult patients was 24 (8) minutes (n=45) with a mean (SD) 25%-
101 75%T₁ recovery index of 13 (7) minutes (n=23) and a mean (SD) time to 70%T₄/T₁ recovery
102 (n=34) of 58 (15) minutes (time from injection to recovery of 70% T₄/T₁).

103
104 TABLE 4: Neuromuscular Function Parameters (Mean (SD)) Following an Initial Dose of RAPLON™ in
105 Geriatric Patients (≥ 65 years)

Dosage	Time to maximum block ^a (sec)	Maximum Block ^b (%)	Clinical Duration ^c (min)	25%-75%T ₁ Recovery Index (min)	Time to 70%T ₄ /T ₁ recovery ^d (min)
RAPLON™ 1.5 mg/kg	89 (6) (n=6)	98 (5) (n=17)	17 (5) (n=16)	11 (6) (n=4)	36 (5) (n=12)

106 a= time from injection to maximum block (peak effect)

107 b= (100 - % T₁ control at peak effect)

108 c= time from injection to return to 25% of control T₁

109 d= time from injection to recovery of 70% T₄/T₁

110
111 In U.S. clinical trials, in geriatric patients (≥ 65 years), the mean (SD) time to maximum block [time
112 from injection to maximum block (peak effect)] following an initial 2.5 mg/kg dose of RAPLON™
113 was 51 (21) seconds (n=4). The mean (SD) clinical duration (time from injection to return to 25%
114 of control T₁) was 43 (37) minutes (n=13) with a mean (SD) 25%-75%T₁ recovery index of 17 (16)
115 minutes (n=3) and a mean (SD) time to 70%T₄/T₁ recovery (n=9) of 76 (20) minutes (time from
116 injection to recovery of 70% T₄/T₁).

117
118 Table 5 presents the neuromuscular function parameters following an initial dose of RAPLON™ in
119 pediatric patients under halothane anesthesia.

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TABLE 5: Neuromuscular Function Parameters Following an Initial Dose of RAPLON™ in Pediatric patients (1 month to ≤ 12 years)

Age Group	Dosage	Time to maximum block ^a (sec)	Maximum Block ^b (%)	Clinical Duration ^c (min)	25%-75%T ₁ Recovery Index (min)	Time to 70%T ₄ /T ₁ recovery ^d (min)
Infants (1mo to < 2yrs)	RAPLON™ 1 mg/kg (n=14)	88 (73)	96 (12)	9 (3) (n=13)	7 (4) (n=9)	20 (7) (n=12)
	RAPLON™ 2 mg/kg (n=16)	84 (66)	99 (3)	16 (7)	13 (11) (n=8)	34 (13)
Children (2 to 12yrs)	RAPLON™ 2 mg/kg (n=23)	53 (16)	100 (1)	14 (7)	6 (4) (n=19)	26 (9) (n=21)
	RAPLON™ 3 mg/kg (n=21)	67 (44)	100 (2)	18 (3) (n=20)	11 (6) (n=12)	37 (9) (n=19)

123 a= time from injection to maximum block (peak effect)
 124 b= (100 - % T₁ control at peak effect)
 125 c= time from injection to return to 25% of control T₁
 126 d= time from injection to recovery of 70% T₄/T₁

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Cardiac Patients

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Hemodynamic parameters were assessed in patients with coronary artery and valvular disease receiving 1.5 mg/kg of RAPLON™ in one US (n=14) and one European (n=18) placebo controlled trial. Overall, there were mild to moderate changes in hemodynamic parameters (e.g., mean arterial pressure, heart rate, mean pulmonary artery pressure, pulmonary capillary wedge pressure, central venous pressure, cardiac index, and systemic vascular resistance index) measured invasively, in cardiac patients (valvular disease or coronary artery disease) receiving 1.5 mg/kg RAPLON™.

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Obese Patients

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Obese patients with a body mass index (BMI) ≥ 30 kg/m² were compared to normal weight subjects in a European study in which they received 1.5 mg/kg of RAPLON™ as part of a rapid sequence induction of anesthesia using either fentanyl/thiopental or alfentanil/propofol. Patients were dosed based on actual body weight. Acceptable (excellent or good) intubating conditions following 1.5 mg/kg of RAPLON™ were similar in obese (86% under fentanyl/thiopental, 92% under alfentanil/propofol) and normal weight subjects (87% under fentanyl/thiopental, 91% under alfentanil/propofol) at 60 seconds. The percent of excellent scores under fentanyl/thiopental or alfentanil/propofol were 48% and 65%, respectively in obese patients, and 44% and 52%, respectively, in normal weight patients.

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Repeat Dosing in Adults

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In three controlled clinical trials, after an initial intubating dose of RAPLON™ of 1.5 mg/kg, 3 additional doses of 0.5 to 0.55 mg/kg were administered at 25% recovery of T₁ or at the reappearance of T₃ (n=76). The duration of action of maintenance doses of 0.5 to 0.55 mg/kg ranged from 3 to 35 minutes. A statistically significant increase in the duration of action of RAPLON™ was noted with subsequent maintenance doses (See Table 6).

157 Table 6: Clinical Duration (25% Recovery of T₁) of Maintenance Doses of Raplon (minutes) following an
158 initial intubating dose of 1.5 mg/kg

	Study 1 Raplon 0.55 mg/kg	Study 2 Raplon 0.5 mg/kg	Study 3 Raplon 0.5 mg/kg
Dose No. 1	(n=15)	(n=28)	(n=33)
Mean (SD)	7 (3)	12 (3)	13 (3)
Median	6	12	13
Range	3-12	6-19	7-20
Dose No. 2	(n=15)	(n=28)	(n=33)
Mean (SD)	8 (2)	14 (4)	15 (5)
Median	8	14	14
Range	5-12	6-22	8-29
Dose No. 3	(n=14)	(n=25)	Not measured
Mean (SD)	8 (2)	16 (6)	
Median	8	15	
Range	5-13	6-35	

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Early Reversal

Administration of neostigmine (50 or 70 mcg/kg at 2 or 5 min) at profound neuromuscular block (> 90%) following administration of either 1.5 or 2.5 mg/kg of RAPLON™ (rapacuronium bromide) for Injection in adults reduced the recovery time by approximately 50%. After early reversal with neostigmine, a decrease in neuromuscular function did not occur over the clinical trial period.

Table 7 presents the recovery parameters following reversal of profound block from a US study of adult patients. Anesthesia consisted of premedication with midazolam, induction with fentanyl and propofol, and maintenance with N₂O supplemented with fentanyl and propofol.

TABLE 7: Recovery Profile Following Neostigmine Reversal at Profound RAPLON™-induced Block (> 90%) in Adults (18 to 64 years)

RAPLON™ Dose	Neostigmine Dose	Time of Neostigmine Administration	Clinical Duration (min)	25%-75%T ₁ Recovery Index (min)	Time to 70%T ₄ /T ₁ recovery (min)	Time to 80%T ₄ /T ₁ recovery (min)
1.5 mg/kg	None	N/A (n=11)	17 (5) ^a	12 (5) ^a	38 (10) ^a	43 (12) ^a
	50 mcg/kg	2 min (n=7)	8 (1)	5 (1)	17 (4)	20 (5)
		5 min (n=12)	9 (1)	5 (3)	17 (3)	19 (4)
	70 mcg/kg	2 min (n=10)	8 (1)	7 (4)	15 (3)	21 (7)
		5 min (n=9)	9 (1)	6 (2)	19 (8)	24 (8)
2.5 mg/kg	None	N/A (n=10)	24 (5) ^a	15 (6) ^a	56 (13) ^a	60 (11) ^a
	50 mcg/kg	2 min (n=12)	12 (2)	9 (4)	26 (7)	31 (8)
		5 min (n=8)	12 (3)	8 (3)	32 (13)	38 (18)
	70 mcg/kg	2 min (n=9)	12 (2)	12 (5) ^b	35 (8)	41 (10)
		5 min (n=9)	12 (2)	8 (3)	28 (9)	36 (12)

172 a= p < 0.03 for comparisons with each early reversal with neostigmine
173 b=(p=NS)

174 Hemodynamics

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176 After the administration of RAPLON™ (rapacuronium bromide) for Injection, dose-related
177 increases in heart rate were observed, peaking within the first few minutes after RAPLON™
178 administration. These changes in heart rate were generally mild to moderate and were stable or
179 near baseline levels within 5 to 10 minutes of RAPLON™ administration. After the administration
180 of RAPLON™, dose-related decreases in mean arterial pressure (MAP) were observed.
181 Decreases in MAP occurred after all doses of RAPLON™. These changes were observed to peak
182 within 5 minutes after the administration of RAPLON™, returning toward baseline by 10 minutes.

183
184 Increases in heart rate and decreases in mean blood pressure were also observed in the pediatric
185 population. In neonates, infants, and children treated with RAPLON™, the observed changes of
186 increased heart rate and decreased mean blood pressure were generally small in magnitude (see
187 CLINICAL PHARMACOLOGY, Clinical Studies).

188
189 Dose- and duration-related adverse ECG changes were observed in nonclinical studies in dogs.
190 These changes included prolongation of the QT interval after dosing 2 times per week over 4
191 weeks, at a total dosage of 18 mg/kg/day given in 3 divided doses, and prolongation of QT
192 interval, sinus arrhythmia, lengthened PR intervals, P wave widening, and AV dissociation
193 following a bolus dose of 27 mg/kg given at 30 minutes after an uneventful first dose of 13.5
194 mg/kg. In the cat, right bundle branch block pattern and prolonged PR intervals were observed
195 following a bolus dose of 26 mg/kg given at 30 minutes after an uneventful first dose of 13 mg/kg.
196 Therefore, potential adverse ECG effects in humans should be considered when RAPLON™ is
197 given in a high bolus dose or following prolonged infusion.

198
199 Electrocardiogram parameters (QT, QTc, and RR intervals) were assessed in patients during a 15
200 minute observation period after receiving 1.5 mg/kg RAPLON™ (n=18) and placebo (n=16) in a
201 European study. Mean QT interval decreases up to 0.015 second from baseline were observed in
202 the RAPLON™ group while small increases of up to 0.082 second were observed in the placebo
203 group. Mean changes in the QTc interval during the 15-minute period ranged from a decrease of
204 0.025 second to an increase of 0.052 second from baseline in the RAPLON™ group compared to
205 increases of up to 0.04 second in the placebo group. Mean changes in the RR interval ranged
206 from 0.101 to 0.024 second in the RAPLON™ group and up to 0.113 second in the placebo
207 group. The clinical significance of these changes is unknown.

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209 Histamine Release

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211 Plasma histamine release was assessed following administration of RAPLON™ (rapacuronium
212 bromide) for Injection (1.0, 2.0, and 3.0 mg/kg) in a US study (n=46). Increases in plasma
213 histamine levels peaked at 1 minute following 2.0 and 3.0 mg/kg of RAPLON™. The elevation in
214 histamine levels was dose-related; 1/16, 2/15, and 6/15 subjects in the 1.0 mg/kg, 2.0 mg/kg, and
215 3.0 mg/kg groups, respectively, demonstrated clinically significant elevations of histamine levels
216 (clinical significance defined as ≥ 1 ng/mL or 100% increase from baseline). Two of six patients in
217 the 3.0 mg/kg group with clinically significant elevations of histamine levels had $\geq 30\%$ increase in
218 heart rate and $\geq 30\%$ decrease in blood pressure after the administration of RAPLON™.

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220 Events possibly related to histamine release (e.g., erythema, bronchospasm) occurred in 29
221 (5.1%) of 564 adult patients in US studies and in 43 (5.8%) of 736 adult patients in European
222 studies.

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224 Intraocular Pressure

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226 In a clinical study, intraocular pressure following a single bolus dose of 1.5 mg/kg of RAPLON™
227 (rapacuronium bromide) for Injection (n=8) decreased by a maximum of 15% at 3 minutes.

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Pharmacokinetics

Data from the *in vivo* pharmacokinetic studies were used to develop population estimates of the parameters for the subpopulations represented (e.g., geriatric, pediatric, renal insufficiency, and hepatic insufficiency). These population-based estimates and a measure of the estimated variability are contained in the following sections.

Following intravenous administration of RAPLON™ (rapacuronium bromide) for Injection, plasma concentration data were best described by a three-compartment model. The pharmacokinetic model was parameterized in clearances and volumes. Estimates of these parameters were used subsequently to calculate volume of distribution at steady state and half-lives. Table 8 presents the results of a population pharmacokinetic analysis from 206 adult patients (18 to 83 years), including patients with end-stage renal disease (n=7) and cirrhosis (n=8). The variability for these parameters is not available from this analysis. See Tables 11 and 12 for variability estimates for these parameters.

TABLE 8: Population Pharmacokinetic Parameter Estimates for RAPLON™^a

PK Parameter	Estimate	CV ^b
Plasma Clearance (mL/kg/min)	6.56	2.5%
Volume of Distribution at Steady State (mL/kg)	292	ND ^c

247 a= Based on basic three compartment model without covariates

248 b= Coefficient of variation (%)

249 c= Not determined for derived parameters

250

Distribution

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253 The mean volume of distribution of RAPLON™ at steady state was 292 mL/kg in adult patients.
254 The mean rapid distribution half-life was 4.56 minutes and the mean slow distribution half-life was
255 27.8 minutes.

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Metabolism

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259 Rapacuronium bromide undergoes hydrolysis of the acetyloxy-ester bond at the 3-position to form
260 the 3-hydroxy metabolite, the major and active metabolite of rapacuronium. Relative to its parent,
261 the 3-hydroxy metabolite has greater potency and a slower onset of action. This hydrolysis is non-
262 specific and can occur at physiological temperature and pH. This hydrolysis may also be
263 catalyzed by esterases of unknown identity and at unknown sites. The cytochrome P450 enzyme
264 system does not appear to be involved in the hydrolysis of rapacuronium bromide. A mass
265 balance study suggests that there may be seven additional minor metabolites of unknown identity
266 in addition to the 3-hydroxy metabolite.

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Elimination

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270 A mass balance study using 1.5 mg/kg of [¹⁴C] rapacuronium bromide demonstrated that urine
271 and feces are the main routes of elimination of [¹⁴C] rapacuronium bromide (Table 9). The mean
272 combined excretion in urine and feces at the end of the continuous 13.5-day collection period was
273 approximately 56% (range: 50%-64%), with approximately 28% excreted in urine samples and
274 28% in feces. Measurable concentrations of radiocarbon were also detected in urine samples
275 collected once a week over four weeks after the end of the continuous 13.5-day collection period.

276 The estimated radioactivity excreted in expired CO₂ over 24 hours was approximately 0.6% of the
 277 administered dose. The apparent elimination half-life of radioactivity was estimated to be
 278 approximately 22 days, suggesting that complete excretion can take several weeks.
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280 TABLE 9: Recovery of Radioactivity ^a From Volunteers (n = 6) Given [¹⁴C] Rapacuronium

Source	Percentage Recovery mean (SD)	Duration of Sampling
Urine	28.4 (4.3)	13.5 days
Stool	27.7 (4.2)	13.5 days
Exhaled Gas ^b	0.6 (0.07)	24 hours
Total ^c	56 (5) (range 50-64%)	13.5 days

281 ^a=Radioactivity recovery does not distinguish between rapacuronium and the 3-hydroxy metabolite
 282 ^b=Sampling started 2 hours after anesthesia recovery and a total of 7 samples were collected
 283 ^c=Excluding exhaled gas

284
 285 Rapacuronium bromide, in addition to undergoing hydrolysis to its 3-hydroxy metabolite, is also
 286 excreted unchanged in urine and feces. The 3-hydroxy metabolite is excreted unchanged in urine
 287 and feces without further biotransformation. Approximately 8% of the administered rapacuronium
 288 bromide dose was recovered from urine up to 48 hours after dosing as unchanged rapacuronium
 289 bromide and approximately 5% as the 3-hydroxy metabolite (Table 10).

290 TABLE 10: Recovery of Rapacuronium Bromide and the 3-hydroxy metabolite From a 48-Hour Urine
 291 Collection of Volunteers (n = 10) Given Unlabelled Rapacuronium Bromide

Compound Excreted in Urine mean (SD)	Time After RAPLON™ 1.5mg/kg Bolus	
	0 - 24 hours	0 - 48 hours
Rapacuronium Bromide (% excreted)	7.96 (2)	8.12 (2)
3-hydroxy metabolite (%) excreted	3.43 (1)	4.96 (1.2)

293 The mean plasma clearance of rapacuronium bromide in adult patients was 6.56 mL/kg/min and
 294 the mean plasma elimination half-life (T_{1/2β}) was 141 minutes. However, this half-life may not
 295 represent the terminal elimination of rapacuronium bromide from the body as characterized in the
 296 mass balance study.
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 299 Protein Binding

300 Plasma protein binding of rapacuronium was studied *in vitro* for human plasma by equilibrium
 301 dialysis. The protein binding was variable and ranged between 50% and 88%, which was at least
 302 partly due to hydrolysis of rapacuronium bromide to its 3-hydroxy metabolite. The specific plasma
 303 protein to which rapacuronium binds is unknown. Plasma protein binding of the 3-hydroxy
 304 metabolite was not determined.
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306
 307 Special Populations

308
 309 Geriatrics

310 In the pooled population pharmacokinetic analysis based on 206 adult patients ages 18 to 83
 311 years, the analysis of covariates showed that total plasma clearance of rapacuronium bromide
 312 decreases with increasing age. However, as these changes were not clinically significant, no
 313 dosage adjustment is recommended for geriatric patients.
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315
 316 Pediatrics

317 Pharmacokinetic parameters in pediatric patients (n=49) ranging in age from 1 month to 12 years
 318 (median 3 years) were estimated using population pharmacokinetic (PK) analyses. The plasma
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320 concentration data were best described by a three-compartment model in which all PK
 321 parameters were proportional to body weight. The mean plasma clearance was 10.6 mL/kg/min.
 322 The mean volume of distribution at steady state was 495 mL/kg and the mean elimination half-life
 323 was 262 min (see PRECAUTIONS, Pediatric Use).
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325 Gender

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 327 In general, studies in normal adult subjects did not reveal any differences in the pharmacokinetics
 328 of RAPLON™ due to gender.
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330 Race

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 332 Race was not examined as a covariate in the pooled population pharmacokinetic analysis of
 333 RAPLON™.
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335 Renal Insufficiency

336
 337 Table 11 summarizes the results of conventional PK analyses from a US study of normal
 338 volunteers and patients with end-stage renal disease (ESRD) receiving a single bolus dose of 1.5
 339 mg/kg of RAPLON™. Patients with renal insufficiency had a mean 30% reduction in clearance
 340 compared with normal adult patients. The volume of distribution was more variable in patients with
 341 renal insufficiency compared to normal volunteers.
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343 Comparison of the concentration of the 3-hydroxy metabolite relative to that of rapacuronium
 344 bromide up to eight hours after rapacuronium bromide administration and the plasma
 345 concentration versus time profiles between the normal volunteer group and patients with ESRD
 346 showed that the pharmacokinetics of the 3-hydroxy metabolite were altered in patients with
 347 ESRD. In normal volunteers, the ratio of the 3-hydroxy metabolite to rapacuronium increased
 348 steadily through the 6-hour period but decreased by the 8-hour time point (from 0.03 at 3 minutes
 349 to 4.5 at 8 hours). In patients with ESRD, this ratio showed an increasing trend even at the 8-hour
 350 time point (from 0.02 at 3 minutes to 7.5 at 8 hours). The decrease in the plasma concentration of
 351 the 3-hydroxy metabolite in patients with ESRD was only 35% from peak levels (265 to 171
 352 ng/mL) compared to an 87% decrease in the normal volunteer group (381 to 49 ng/mL). No clear
 353 elimination phase was observed at the end of 8 hours. Despite the persistence of the 3-hydroxy
 354 metabolite, neuromuscular function recovered completely with a mean time course to 70% T₄/T₁
 355 only slightly longer in patients with ESRD, compared to that in healthy volunteers with normal
 356 renal function after a single 1.5 mg/kg bolus. However, it is likely that recovery from supplemental
 357 doses of RAPLON™ will be prolonged in patients with renal failure.
 358

359 TABLE 11: Estimates of PK Parameters of RAPLON™ in Normal Volunteers and Patients With
 360 ESRD

PK Parameter	Normal Volunteers ^a	Patients with ESRD ^a
Elimination Half-Life ^c (t _{1/2β} , min)	240 (97)	198 (141) ^b
Volume of Distribution at Steady State (mL/kg)	431.7 (78)	440.3 (347)
Plasma Clearance (mL/kg/min)	9.4 (2.2)	6.1 (1.7) ^b

361 a= Normal volunteers n=10, patients with ESRD n=9, values are mean (SD)
 362 b= p ≤ 0.05 for comparison with normal volunteers
 363 c= May not represent the slow elimination kinetics of rapacuronium bromide

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Hepatic Insufficiency

The pharmacokinetic (PK) parameters for patients with mild to moderate hepatic insufficiency and patients with normal liver function are presented in Table 12. These estimates are based on conventional PK analyses. Plasma clearance and volume of distribution at steady-state are greater in patients with cirrhosis compared to patients with normal liver function. Pharmacokinetics of rapacuronium bromide in patients with severe hepatic impairment have not been evaluated.

TABLE 12: Estimates of PK Parameters of RAPLON™ in Patients With Normal Liver Function and Patients With Hepatic Insufficiency

PK Parameter	Normal Liver Function ^a	Hepatic Insufficiency (cirrhotic) ^a
Elimination Half-Life ^c (t _{1/2β} , min)	84 (4)	88 (6)
Volume of Distribution at Steady State (mL/kg)	252 (77)	465 (82) ^b
Plasma Clearance (mL/kg/min)	6.6 (1.7)	9.0 (1.4) ^b

375 a= Normal liver function n=7, hepatic insufficiency n=6, values are mean (SD)
376 b= p ≤ 0.01 for comparison with normal patients
377 c= May not represent the slow elimination kinetics of rapacuronium bromide. Values are harmonic mean
378 and standard error of harmonic mean. Harmonic mean is calculated based on 0.693/t_{1/2β}.

379
380

Drug-Drug Interactions

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382
383
384

There were no specific pharmacokinetic studies conducted to examine the drug-drug interactions of RAPLON™ (see PRECAUTIONS).

385
386

Clinical Studies

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392

In US studies, 929 patients received RAPLON™ (rapacuronium bromide) for Injection including 219 pediatric, 146 geriatric, and 20 obstetric patients. In European studies, 964 patients received RAPLON™ including 165 pediatric and 63 geriatric patients. The majority of patients, 91%, were ASA (American Society of Anesthesiologists) Class I or II, approximately 8 % were ASA Class III, and approximately 1% were ASA Class IV.

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Neuromuscular function parameters following administration of RAPLON™ succinylcholine, and mivacurium were compared in one clinical study. In direct comparison with succinylcholine and mivacurium, RAPLON™ at the recommended 1.5 mg/kg dose had a mean (SD) onset of action of 98 (46) seconds compared with 67 (27) seconds for succinylcholine and 127 (50) seconds for mivacurium. RAPLON™ had a mean (SD) clinical duration of 15 (6) minutes compared with 9 (3) minutes for succinylcholine and 21 (5) minutes for mivacurium. Table 13 presents these neuromuscular function parameters in patients 18 years of age and older.

405 TABLE 13: Neuromuscular Function Parameters Following an Initial Dose of RAPLON,
 406 Succinylcholine, or Mivacurium in Adults (≥18 years)

Drug/Dosage	Time to Maximum Block ^a (seconds)	Maximum Block ^b (%)	Clinical Duration ^c (minutes)	25-75% T ₁ Recovery Index (minutes)	Time to 70% T ₄ /T ₁ recovery ^d (minutes)
Raplon 1.5 mg/kg					
n	28	28	25	22	16
Mean (SD)	98 (46)	99 (2)	15 (6)	8 (5)	38 (21)
Range	35-219	94-100	7-30	2-21	21-101
Succinylcholine 1 mg/kg					
n	30	30	29	29	N/A
Mean (SD)	67 (27)	99 (2)	9 (3)	2(1)	
Range	31-138	90-100	5-15	1-4	
Mivacurium 0.25 mg/kg^e					
n	25	25	21	24	18
Mean (SD)	127 (50)	100 (0.4)	21 (5)	9 (4)	32 (7)
Range	64-261	99-100	14-29	4-20	22-45

a = time from injection to maximum block (peak effect)
 b = 100 - %T₁ control at peak effect
 c = time from injection to return to 25% of control T₁
 d = time from injection to recovery of 70% T₄/T₁
 e = administered as a divided dose (0.15 mg/kg followed in 30 sec by 0.10 mg/kg), parameter measured from second dose

407
 408 Intubating conditions following administration of RAPLON™ and succinylcholine were compared in
 409 three randomized, multicenter trials conducted in the U.S., France, and Germany. A blinded rater
 410 assessed intubating conditions on the Viby-Mogensen scale (see Table 14) 50 seconds after
 411 administration of the neuromuscular blocking agent. Several different anesthetic techniques were
 412 used. In the U.S. study, fentanyl was given about 5 minutes before intubation followed by propofol
 413 one to two minutes before intubation. The French study was similar except that thiopental was
 414 used instead of propofol. The German study tested a rapid sequence, with initiation of
 415 administration of the neuromuscular blocking agent within a few seconds after the end of the
 416 injection of the hypnotic, either fentanyl and thiopental or alfentanil and propofol were used at
 417 random. Tables 15 and 16 show the intubation scores in adults (18 to 64 years) and in geriatric
 418 patients (≥65 years).
 419
 420

TABLE 14: Viby-Mogensen Scale

	CLINICALLY ACCEPTABLE		
	Excellent†	Good‡	Poor‡
Vocal Cord Position	Abducted	Intermediate	Closed
Vocal Cord Movement	None	Moving	Closing
Easiness of Laryngoscopy*	Easy	Fair	Difficult
Airway Reaction	None	Diaphragm	Sustained >10 sec
Movement of Limbs	None	Slight	Vigorous

421 *Easy: Jaw relaxed; no resistance
 422 Fair: Jaw relaxed; slight resistance
 423
 424 †Excellent: All items excellent
 425 Good: All items excellent or good
 426 Poor: Any item poor
 427
 428

429 Intubating dosages of 1.5 and 2.5 mg/kg of RAPLON™ were evaluated in 784 patients. A
 430 population of patients undergoing Cesarean section was also studied (see below).
 431

432
 433 TABLE 15: Intubation Scores in Adults (18 to 64 years) With Laryngoscopy Initiated at 50 Seconds
 434 following Administration of RAPLON™ or succinylcholine

Study	U.S.		France		Germany	
	RAPLON™ 1.5 mg/kg n = 124	Succinyl- choline 1.0 mg/kg n = 112	RAPLON™ 1.5 mg/kg n = 128	Succinyl- choline 1.0 mg/kg n = 128	RAPLON™ 1.5 mg/kg n = 160	Succinyl- choline 1.0 mg/kg n = 156
Excellent	43%	67%	30%	48%	51%	73%
Good	44%	29%	55%	41%	39%	24%
Poor	13%	4%	9%	9%	11%	3%
Impossible	0%	2%	5%	2%	0%	0%

435
 436 TABLE 16: Intubation Scores in Geriatric Patients (≥65 years) With Laryngoscopy Initiated at 50 Seconds
 437 after Administration of RAPLON™ or succinylcholine

Study	U.S.		France	
	RAPLON™ 1.5 mg/kg n = 26	Succinylcholine 1.0 mg/kg n = 28	RAPLON™ 1.5 mg/kg n = 25	Succinylcholine 1.0 mg/kg n = 26
Excellent	50%	79%	32%	62%
Good	46%	21%	48%	35%
Poor	4%	0%	4%	0%
Impossible	0%	0%	16%	4%

438 Intubating conditions were also studied in pediatric patients (≥ 1 month to ≤ 12 years) in one non-
 439 comparative European study. Patients were premedicated with midazolam and induced with
 440 thiopental. Results are presented in Table 17.
 441

442
 443 TABLE 17: Intubation Scores in Pediatric Patients With Laryngoscopy Initiated at 50 Seconds after
 444 Administration of RAPLON™

	Infants (1 mo to 1 yr) 2.0 mg/kg n = 9	Children (1 to 12 yr) 2.0 mg/kg n = 17
Excellent	100%	59%
Good	0%	41%
Poor	0%	0%
Impossible	0%	0%

445

446 Cesarean Section

447
448 In a controlled clinical trial, patients undergoing rapid sequence induction of anesthesia for
449 Cesarean section received thiopental 4 - 6 mg/kg followed by 2.5 mg/kg of RAPLON™ or 1.5
450 mg/kg of succinylcholine. Laryngoscopy was initiated 50 seconds after the muscle relaxant was
451 administered and intubation completed by 60 seconds in all patients. Acceptable (excellent or
452 good) intubating conditions were achieved in 14/15 (93%) patients receiving RAPLON™ and in
453 17/19 (89%) patients receiving succinylcholine. Excellent scores were recorded in 10/15 (67%)
454 RAPLON™ patients and 13/19 (68%) succinylcholine patients.

455
456 No neonates born of mothers who received RAPLON™ during Cesarean section had APGAR
457 scores below 6 at 5 minutes post-delivery or NAC (Neurological and Adaptive Capacity) scores
458 < 30 at 24 hours post-delivery.

459
460 The venous umbilical/maternal concentrations of RAPLON™ (median 8.4%, range of 4.4 to
461 16.1%) and its 3-hydroxy metabolite (median 10.2, range of 4.6% to 19.9%) demonstrated that
462 there is some placental transfer of the drug from the maternal blood to the fetal blood at delivery.

463
464 Individualization of Dosage

465
466 DOSES OF RAPLON™ (rapacuronium bromide) FOR INJECTION SHOULD BE
467 INDIVIDUALIZED AND A PERIPHERAL NERVE STIMULATOR SHOULD BE USED TO
468 MEASURE NEUROMUSCULAR FUNCTION DURING RAPLON™ ADMINISTRATION IN
469 ORDER TO MONITOR DRUG EFFECT, DETERMINE THE NEED FOR ADDITIONAL DOSES,
470 AND CONFIRM RECOVERY FROM NEUROMUSCULAR BLOCK.

471
472 Based on the known actions of rapacuronium bromide and other neuromuscular blocking agents,
473 the following factors should be considered when administering RAPLON™.

474
475 Renal or Hepatic Impairment

476
477 A slight delay in the onset of neuromuscular block and prolongation of duration of block were
478 observed in patients with ESRD when compared to normal volunteers. A greater variability of
479 onset and duration was also observed in patients with renal insufficiency. The mean time to 25%-
480 75%T₁ recovery was greater in patients with renal and hepatic impairment. Although dosage
481 adjustments are not recommended in patients with renal or hepatic impairment, RAPLON™
482 should be used with caution in these patient populations.

483
484 The results of studies in patients with renal failure and hepatic dysfunction do not suggest any
485 additional safety concerns in these patients when RAPLON™ is administered as a single dose.

486
487 Reduced Plasma Cholinesterase Activity

488
489 RAPLON™ metabolism does not depend on plasma cholinesterase, therefore, no differences in
490 clinical effect are expected in patients with reduced or normal plasma cholinesterase activity.

491
492 Drugs or Conditions Causing Potentiation of, or Resistance to, Neuromuscular Block

493
494 Use of inhalation anesthetics (enflurane, isoflurane, halothane, desflurane, sevoflurane) has been
495 shown to enhance the activity of other neuromuscular blocking agents (see PRECAUTIONS,
496 Drug Interactions, Inhalational Anesthetics).

497
498 Magnesium salts, lithium, local anesthetics, procainamide, quinidine, and certain antibiotics have
499 been shown to increase the duration of neuromuscular block and decrease infusion requirements

500 of other neuromuscular blocking agents. In patients in whom potentiation of neuromuscular block
501 may be anticipated, a decrease from the recommended initial dose of Raplon should be
502 considered (see PRECAUTIONS, Drug Interactions, Other).

503
504 Severe acid-base and/or electrolyte abnormalities may potentiate or cause resistance to the
505 neuromuscular blocking action of RAPLON™.

506
507 Resistance to non-depolarizing agents, consistent with up-regulation of skeletal muscle
508 acetylcholine receptors, is associated with burns, disuse atrophy, denervation, and direct muscle
509 trauma. Receptor up-regulation may also contribute to the resistance to nondepolarizing muscle
510 relaxants that sometimes develops in patients with cerebral palsy and in patients with chronic
511 exposure to anticonvulsant or nondepolarizing agents (see PRECAUTIONS, Drug Interactions).

512
513 Other nondepolarizing neuromuscular blocking agents have been found to exhibit profound effects
514 in cachectic or debilitated patients, patients with neuromuscular diseases, and patients with
515 carcinomatosis. In these or other patients in whom potentiation of neuromuscular block or difficulty
516 with reversal may be anticipated, a decrease from the recommended initial dose of Raplon should
517 be considered.

518
519 Obesity

520
521 In obese patients, the initial dose of RAPLON™ should be based upon the patient's actual body
522 weight (see CLINICAL PHARMACOLOGY, Obese Patients).

523
524 The neuromuscular blocking effect of 1.5 mg/kg RAPLON™ was determined in a group of obese
525 patients (body mass index ≥ 30) and a group of non-obese patients (body mass index 20 - 28).
526 When dosed by actual body weight, the obese group had approximately the same percentage of
527 patients with acceptable (excellent or good) intubating conditions as the non-obese group.

528
529 Although RAPLON™ has not been formally studied in morbidly obese patients (body mass index
530 ≥ 40), clinicians should consider dosing this patient population based on ideal body weight. As
531 with other neuromuscular blocking drugs, RAPLON™ may exhibit prolonged duration and delayed
532 spontaneous recovery when the morbidly obese are dosed based on actual body weight.

533
534 Burns

535
536 Patients with burns are known to develop resistance to nondepolarizing neuromuscular blocking
537 agents, probably due to up-regulation of post-synaptic skeletal muscle cholinergic receptors.

538
539 **INDICATIONS AND USAGE**

540
541 RAPLON™ (rapacuronium bromide) for Injection is indicated as an adjunct to general anesthesia
542 to facilitate tracheal intubation, and to provide skeletal muscle relaxation during surgical
543 procedures.

544
545 **CONTRAINDICATIONS**

546
547 RAPLON™ (rapacuronium bromide) for Injection is contraindicated in patients known to have
548 hypersensitivity to rapacuronium bromide.

549
550 **WARNINGS**

551
552 **RAPLON™ (rapacuronium bromide) FOR INJECTION SHOULD BE ADMINISTERED IN**

553 CAREFULLY ADJUSTED DOSAGE BY OR UNDER THE SUPERVISION OF EXPERIENCED
554 CLINICIANS WHO ARE FAMILIAR WITH THE DRUG'S ACTIONS AND THE POSSIBLE
555 COMPLICATIONS OF ITS USE. THE DRUG SHOULD NOT BE ADMINISTERED UNLESS
556 PERSONNEL AND FACILITIES FOR RESUSCITATION AND LIFE SUPPORT (TRACHEAL
557 INTUBATION, ARTIFICIAL VENTILATION, OXYGEN THERAPY), AND AN ANTAGONIST OF
558 RAPLON™ ARE IMMEDIATELY AVAILABLE. IT IS RECOMMENDED THAT ADEQUATE
559 NEUROMUSCULAR MONITORING EQUIPMENT, SUCH AS A PERIPHERAL NERVE
560 STIMULATOR, BE USED TO MEASURE NEUROMUSCULAR FUNCTION DURING THE
561 ADMINISTRATION OF RAPLON™ IN ORDER TO MONITOR DRUG EFFECT, DETERMINE
562 THE NEED FOR ADDITIONAL DOSES, AND CONFIRM RECOVERY FROM
563 NEUROMUSCULAR BLOCK.

564
565 RAPLON™ HAS NO KNOWN EFFECT ON CONSCIOUSNESS, PAIN THRESHOLD, OR
566 CEREBRATION. TO AVOID DISTRESS TO THE PATIENT, NEUROMUSCULAR BLOCK
567 SHOULD NOT BE INDUCED BEFORE UNCONSCIOUSNESS. THEREFORE,
568 ADMINISTRATION OF RAPLON™ MUST BE ACCOMPANIED BY ADEQUATE ANESTHESIA
569 OR SEDATING AGENTS.

570 571 **Long-Term Use**

572
573 RAPLON™ (RAPACURONIUM BROMIDE) FOR INJECTION, SHOULD NOT BE
574 ADMINISTERED BY INFUSION PARTICULARLY IN THE INTENSIVE CARE UNIT (ICU), OR
575 DURING LONG SURGICAL PROCEDURES. In an infusion study (n=90) with RAPLON™, one
576 patient displayed a deterioration of neuromuscular function after attaining evidence of adequate
577 spontaneous recovery. Six minutes after spontaneously recovering to a T_4/T_1 of 70%, the T_4/T_1
578 decreased to 64%. Thirteen minutes later T_4/T_1 recovered to 80%. This patient did not receive
579 neostigmine and had no respiratory problems that required reintubation or mask assisted
580 breathing.

581
582 Radioisotope studies have demonstrated that only 56% of the original Raplon dose had been
583 excreted two weeks following a single IV bolus. Excretion of ¹⁴C-labeled rapacuronium continued
584 for at least six weeks. Accumulation of rapacuronium bromide following repeat dosing is likely to
585 occur but has not been studied.

586
587 ECG abnormalities have been observed in animals following repeat doses and large single doses
588 of rapacuronium bromide (See CLINICAL PHARMACOLOGY, Hemodynamics).

589
590 During pregnancy there is passage of low levels of rapacuronium across the placenta and slow
591 elimination following a single maternal dose (see CLINICAL PHARMACOLOGY,
592 PHARMACOKINETICS). The risk to the developing fetus from extended low-dose intrauterine
593 exposure to a neuromuscular blocking agent is unknown. Because of these concerns and
594 because animal reproduction studies are not always predictive of human response, this drug
595 should not be used during pregnancy unless the potential benefit to the patient outweighs the
596 potential risk to the fetus. This warning does not extend to use of RAPLON™ during Cesarean
597 section, but appropriate monitoring of the infant is recommended after delivery (see CLINICAL
598 PHARMACOLOGY, Clinical Studies).

599
600 In patients with myasthenia gravis or myasthenic (Eaton-Lambert) syndrome, small doses of
601 nondepolarizing neuromuscular blocking agents may have profound effects. In such patients, a
602 peripheral nerve stimulator and use of a small test dose may be of value in monitoring the
603 response to administration of muscle relaxants.

604
605 Reconstituted RAPLON™, which has an acid pH of 4.0, should not be mixed with alkaline
606 solutions (e.g., barbiturate solutions) in the same syringe or administered simultaneously during

607 intravenous infusion through the same needle.

608

609 **PRECAUTIONS**

610

611 **Repeat Dosing**

612

613 It is strongly recommended that during administration of Raplon™, neuromuscular transmission
614 and recovery be monitored continuously using a nerve stimulator. Additional doses of Raplon™
615 should not be given until there is a definite response (one twitch of the train-of-four) to nerve
616 stimulation.

617

618 Repeat dosing in adults after intubating doses greater than 1.5 mg/kg, and repeat dosing in
619 pediatric patients have not been studied, and are, therefore, not recommended.

620

621 The experience with a limited number of patients indicates that repeat bolus dosing of Raplon™
622 may have a potential for prolonged block. Theoretically, increased histamine effects may result
623 from slow elimination of the drug from the body; however, no studies to date have been conducted
624 to substantiate this possibility (see CLINICAL PHARMACOLOGY, Pharmacokinetics).

625

626 In three European studies, adult patients were given an intubating dose of 1.5 mg/kg of Raplon™
627 (rapacuronium bromide) for Injection followed by three maintenance doses of Raplon™ 0.5 mg/kg
628 (n=61) or 0.55 mg/kg (n=19). In one study, median (range) clinical durations of the three doses of
629 0.55 mg/kg were 6 (3-12), 8 (5-12), and 8 (5-13) minutes. In the second study, the three
630 maintenance doses of 0.5 mg/kg had median (range) clinical durations of 12 (6-19), 14 (6-22), and
631 15 (6-35) minutes. Neostigmine was administered to half the patients in this study after the third
632 dose when T1 returned to 25%, and the median (range) time to recover to 70% T4/T1 was 6 (2 -
633 9) minutes (n=14). The remaining half of the patients had spontaneous recovery after the third
634 dose. The median spontaneous recovery from 25% T1 to 70% T4/T1 was 57 minutes and ranged
635 from 44 to 80 minutes (n=11). In the third study, the median (range) clinical durations of the first
636 and second maintenance doses of 0.5 mg/kg were 13 (7-20) and 14 (8-29) minutes. Neostigmine
637 (n=12) or edrophonium (n=13) were administered two minutes after the third dose of Raplon.
638 Median (range) recovery time to 70% T4/T1 was 14 (7 - 24) minutes after neostigmine and 33 (19
639 - 49) minutes after edrophonium (see CLINICAL PHARMACOLOGY, Repeat Dosing in Adults).

640

641 In the 80 patients who received three maintenance doses following a bolus dose of 1.5 mg/kg of
642 Raplon™, adverse events reported in separate patients during or following the maintenance
643 doses consisted of hypotension, tachycardia, respiratory depression, and bronchospasm.

644

645 **Drug Interactions**

646

647 Inhalation Anesthetics

648

649 Use of inhalation anesthetics (enflurane, isoflurane, halothane, desflurane, sevoflurane) have
650 been shown to enhance the activity of other neuromuscular blocking agents and may enhance the
651 activity of RAPLON™.

652

653 Intravenous Anesthetics

654

655 In clinical studies, the use of propofol for induction and maintenance of anesthesia did not alter the
656 clinical duration or recovery characteristics of recommended doses of RAPLON™ (rapacuronium
657 bromide) for Injection.

658

659

660

661 **Anticonvulsants**

662
663 As with other nondepolarizing neuromuscular blocking drugs, if RAPLON™ is administered to
664 patients chronically receiving anticonvulsant agents such as carbamazepine or phenytoin, shorter
665 durations of neuromuscular block may occur and infusion rates may be higher due to the
666 development of resistance to nondepolarizing muscle relaxants. While the mechanism for
667 development of this resistance is not known, receptor up-regulation may be a contributing factor.

668
669 **Antibiotics**

670
671 Certain antibiotics (e.g., aminoglycosides, vancomycin, tetracyclines, bacitracin, polymyxin, and
672 colistin) may enhance the neuromuscular blocking action of nondepolarizing agents such as
673 RAPLON™. If these antibiotics are used in conjunction with RAPLON™, prolongation of
674 neuromuscular block should be considered a possibility.

675
676 **Other**

677
678 Magnesium salts, administered for the management of toxemia of pregnancy, may enhance
679 neuromuscular blockade. Experience concerning injection of quinidine during recovery from use of
680 other muscle relaxants suggests that recurrent paralysis may occur. This possibility must also be
681 considered for RAPLON™.

682
683 Other drugs that may possibly enhance the neuromuscular blocking action of nondepolarizing
684 muscle relaxants, such as RAPLON™, include lithium, local anesthetics, procainamide, and
685 quinidine.

686
687 Acid-base and/or serum electrolyte abnormalities may potentiate or antagonize the action of
688 neuromuscular blocking agents.

689
690 **Carcinogenesis, Mutagenesis, Impairment of Fertility**

691
692 Studies in animals to evaluate carcinogenic potential or impairment of fertility with rapacuronium
693 bromide have not been performed. Mutagenicity studies conducted with rapacuronium using the
694 Ames test and the Mouse Lymphoma L5178Y cell assay were negative. An *in vivo* rat bone
695 marrow micronucleus assay for clastogenic activity was also negative for rapacuronium. Two *in*
696 *vitro* human lymphocyte chromosomal aberration assays for clastogenic potential were conducted
697 with rapacuronium. Both assays were negative in the presence of metabolic activation, while in
698 the absence of metabolic activation the first assay was inconclusive and the second assay was
699 positive.

700
701 **Pregnancy**

702
703 **Pregnancy Category C**

704
705 Reproduction studies have been performed in pregnant nonventilated New Zealand White rabbits
706 and nonventilated Sprague Dawley rats. Throughout gestation days 6 - 18, rabbits received 0.75,
707 1.5, or 3 mg/kg/day of rapacuronium bromide by continuous infusion. Rats, during gestation days
708 6 - 17, received intravenous doses of 0.75, 1.5, or 2.25 mg/kg/day of rapacuronium bromide in 3
709 divided doses at 30 minute intervals on each treatment day. No teratogenic effects were observed
710 in rabbits or rats at the highest doses tested. The high doses of 3 and 2.25 mg/kg are
711 approximately 0.3 and 0.1 times the maximum recommended human intravenous dose for adults
712 on a mg/m² basis, respectively. Post-implantation losses, as evidenced by increased resorption,
713 were observed in rabbits at and above the lowest dose of 0.75 mg/kg, which is approximately 0.1
714 times the maximum recommended human intravenous dose for adults on a mg/m² basis.

715 Fetotoxicity, as evidenced by increased fetal deaths and subsequent resorption, was observed in
716 rats at the high dose of 2.25 mg/kg, which is approximately 0.1 times the maximum recommended
717 human intravenous dose for adults on a mg/ m² basis. There are no adequate and well-controlled
718 studies in pregnant women.
719

720 During pregnancy there is passage of low levels of rapacuronium across the placenta and slow
721 elimination following a single maternal dose (see CLINICAL PHARMACOLOGY, Clinical Studies,
722 Cesarean section). The risk to the developing fetus from extended low-dose intrauterine
723 exposure to a neuromuscular blocking agent is unknown. Because of these concerns and
724 because animal reproduction studies are not always predictive of human response, this drug
725 should not be used during pregnancy unless the potential benefit to the patient outweighs the
726 potential risk to the fetus.
727

728 **Labor and Delivery**

729
730 The use of RAPLON™ (rapacuronium bromide) for injection in Cesarean section has been
731 studied in a limited number of patients (see CLINICAL PHARMACOLOGY, Clinical Studies).
732

733 **Nursing Mothers**

734
735 It is not known whether this drug is excreted in human milk or what effects it may have after oral
736 administration. Since many drugs are excreted in human milk, caution should be exercised when
737 RAPLON™ (rapacuronium bromide) for injection is administered to nursing mothers.
738

739 **Pediatric Use**

740
741 RAPLON™ (rapacuronium bromide) for injection single bolus dose administration has been
742 studied in 397 pediatric patients, the majority of whom were ASA Class I and II.
743

744 The use of Raplon has not been studied in pediatric and adolescent patients aged 13-17 years.
745

746 There are insufficient data to recommend the use of RAPLON™ in infants < 1 month of age until
747 more is known about the safety of RAPLON™ in this population.
748

749 The intravenous administration of RAPLON™ has been studied in pediatric patients from 1 month
750 up to 12 years of age. (see CLINICAL PHARMACOLOGY, Clinical Studies and DOSAGE AND
751 ADMINISTRATION). Initial doses of 2 mg/kg intravenously in pediatric patients (ages 1 month to
752 12 years) under halothane anesthesia produce acceptable intubating conditions within 60
753 seconds. Mean maximum block occurred within 90 seconds in most pediatric patients and had a
754 mean clinical duration of 15 minutes. Intubating doses of 3.0 mg/kg in children (2 to 12 years)
755 provided maximum block within 90 seconds and a mean clinical duration of 18 minutes. Sufficient
756 numbers of pediatric patients 1 month of age and older have received RAPLON™ to establish the
757 safety of single-dose administration in this age group.
758

759 No long-term follow-up data are available in pediatric patients exposed to Raplon. Studies have
760 demonstrated small quantities of residual drug remaining in tissues of animals administered a
761 single bolus injection of rapacuronium one week after injection. This small residual was primarily
762 observed in kidney, heart, lung, and pituitary. Elimination kinetics in pediatric patients have not
763 been studied, although elimination in adult humans is known to be slower than in animal species
764 tested. Measurable concentrations of radiolabeled rapacuronium in human urine samples
765 following single-dose administration in adults were detected over a period of 6 weeks. The effect
766 of sequestered drug in tissues theoretically may affect development; however no studies to date
767 have been conducted to substantiate this possibility.

768

769

Geriatric Use

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776

RAPLON™ (rapacuronium bromide) for Injection has been studied in 209 patients ≥ 65 years of age. Advanced age or other conditions associated with slower circulation time, e.g., cardiovascular disease may be associated with a delay in onset time. Nevertheless, the recommended dosage of 1.5 mg/kg should not be increased in these patients to reduce onset time, as higher doses produce a longer duration of action (See CLINICAL PHARMACOLOGY, Pharmacodynamics, Special Populations).

777

778

779

780

781

782

RAPLON™ is known to be substantially excreted by the kidney, and the risk of prolonged effect or other toxic reactions to this drug may be greater in patients with impaired renal function. While elderly patients are more likely to have altered renal function, no dosage adjustments are recommended in geriatric patients.

783

Hepatic Disease

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793

Resistance to neuromuscular blocking agents in patients with hepatic insufficiency has been ascribed to an increase in volume of distribution. RAPLON™ at a dose of 1.5 mg/kg has been studied in a limited number of patients with cirrhosis (n=6) under isoflurane anesthesia. Following 1.5 mg/kg of RAPLON™, the median (range) of clinical duration and recovery rate in patients with cirrhosis were 14 (8 - 18) minutes and 14 (9 - 18) minutes, respectively. These times were similar to the median times of 16 minutes clinical duration and recovery rate of 14 minutes in patients with normal hepatic function. The plasma clearance of rapacuronium was faster and the volume of distribution was greater in patients with cirrhosis compared to normal controls.

794

Renal Failure

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RAPLON™ (rapacuronium bromide) for Injection has been studied at a dose of 1.5 mg/kg in one US study, in patients with end-stage renal disease (n=9) under isoflurane anesthesia. The median (range) onset time in patients with ESRD (83 (38 - 180) seconds) was slow compared to normal volunteers (median onset time 66 seconds). The median clinical duration of 12 minutes (range 6 to 39 minutes) in patients with ESRD was similar to the median time of 13 minutes in normal volunteers. The recovery time from 25%-75% T₁ ranged from 6 to 68 minutes in patients with ESRD.

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Malignant Hyperthermia (MH)

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RAPLON™ (rapacuronium bromide) for Injection has not been studied in MH-susceptible patients. No subjects exposed to RAPLON™ developed MH or any other syndrome suggestive of MH during premarketing clinical studies. In a study with MH-susceptible swine, the administration of RAPLON™ did not trigger malignant hyperthermia. Since RAPLON™ is always used with other agents, and the occurrence of malignant hyperthermia during anesthesia is possible even in the absence of known triggering agents, clinicians should be prepared to diagnose and treat malignant hyperthermia during the administration of any anesthetic.

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Use In Patients With Elevated Intracranial Pressure

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In a clinical trial enrolling patients with head injury in which intracranial pressure was monitored, the effects of RAPLON™ (rapacuronium bromide) for Injection and vecuronium were compared. One patient in the RAPLON™ - treated group developed an increase in intracranial pressure from 17 mmHg to 34 mmHg two minutes after receiving 1.5 mg/kg of RAPLON™. In the same study, a patient in the vecuronium-treated group developed a rise in intracranial pressure from 26 to 45

821 mmHg six minutes after receiving vecuronium 0.1 mg/kg. The results of this study were not
 822 conclusive.

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824 **ADVERSE REACTIONS**

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826 **Pre-Marketing Clinical Trial Experience**

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828 The safety of RAPLON™ (rapacuronium bromide) Injection was evaluated in 2036 subjects in
 829 prospective clinical trials. The majority of use in clinical trials was single bolus intravenous
 830 exposure.

831

832 Incidence of Adverse Events in Controlled Clinical Trials

833

834 The most common adverse event with an incidence of >5% seen with RAPLON™ in controlled
 835 clinical trials was hypotension (5.2%). Table 18 lists treatment-emergent signs and symptoms that
 836 occurred in at least 1% of patients receiving RAPLON™ in controlled clinical trials that were
 837 numerically more frequent than in the active control.

837

838 **TABLE 18: Most Frequent Adverse Events Seen With RAPLON™ in Controlled Clinical Trials**

Body System Adverse Clinical Experience	RAPLON™ n=1956	Succinylcholine n=572	Other Active Controls ^a n=141
Cardiovascular			
Hypotension	5.2%	6.5%	4.3%
Tachycardia	3.2%	0.52%	1.4%
Bradycardia	1.5%	1%	2.1%
Respiratory			
Bronchospasm	3.2%	2.1%	0.71%

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841 Incidence of Other Adverse Events During Premarketing Evaluation of RAPLON™ - in all Treated
 842 Patients

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^a Active Controls include rocuronium bromide, vecuronium bromide, and mivacurium

In the following tabulation, the frequencies represent the proportion of the 1,956 patients exposed to at least one dose of RAPLON™ who experienced an event of the type cited on at least one occasion while receiving RAPLON™. All events reported are included except those already listed in the previous table. Although events reported occurred during treatment with RAPLON™, a causal relationship has not necessarily been established.

Events are further classified within body system categories and enumerated in order of decreasing frequency using the following definitions: frequent adverse events are defined as those occurring in at least 1/100 patients; infrequent adverse events are those occurring in 1/100 to 1/1000 patients; rare events are those occurring in fewer than 1/1000 patients.

Body as a Whole: *Infrequent*: fever, rigors, back pain, hypothermia, chest pain, peripheral edema, pain; *Rare*: asthenia, fatigue, non-inflammatory swelling, therapeutic response decrease.

Cardiovascular: *Infrequent*: hypertension, extrasystoles, abnormal ECG, arrhythmia, cerebrovascular disorder, ventricular fibrillation, atrial fibrillation, ventricular tachycardia; *Rare*: atria arrhythmia, cardiac failure, right cardiac failure, cardio-respiratory arrest, cardiac arrest, thrombophlebitis, supraventricular extrasystoles, supraventricular tachycardia, myocardial infarction, left bundle branch block.

Digestive: *Frequent*: vomiting, nausea; *Infrequent*: ileus, saliva increased; *Rare*: abdominal pain, cholelithiasis, nonspecific gastrointestinal disorder, rectal hemorrhage, esophagospasm, oral hemorrhage, tooth disorder.

- 866
867 Hemic and Lymphatic: *Infrequent*: thrombosis, post-operative bleeding; *Rare*: epistaxis,
868 coagulation factor decrease, purpura, anemia, hemoperitoneum.
869
870 Metabolic and Nutritional: *Rare*: acidosis.
871
872 Musculoskeletal: *Infrequent*: myalgia; *Rare*: muscle weakness, neonatal hypotonia.
873
874 Nervous: *Infrequent*: hypoesthesia, hemiparesis, hypertonia, prolonged neuromuscular block,
875 prolonged anesthesia emergence; *Rare*: headache, cerebral hemorrhage, intracranial pressure
876 increased, migraine, ptosis, tetany, breath holding, confusion, anxiety.
877
878 Respiratory: *Infrequent*: hypoxia, increased airway pressure, hypoventilation, laryngismus,
879 coughing, apnea, respiratory depression, upper airway obstruction, neonatal respiratory distress
880 syndrome, pneumothorax, pulmonary edema, respiratory insufficiency, stridor; *Rare*: pharyngitis,
881 larynx edema, dyspnea, neonatal respiratory depression, hyperventilation, rhinitis, sputum
882 increase.
883
884 Skin: *Frequent*: erythematous rash; *Infrequent*: Injection site reaction, injection site pain, rash,
885 urticaria, pruritis, sweating increased; *Rare*: paravenous injection.
886
887 Special Senses: *Rare*: corneal ulceration, meiosis decreased hearing.
888
889 Urogenital: *Infrequent*: urinary retention, oliguria; *Rare*: abnormal renal function, urinary tract
890 infection, pelvic inflammation, vaginal bleeding.
891

892 OVERDOSAGE

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894 In premarketing clinical studies, one case of accidental overdose with RAPLON™ (rapacuronium
895 bromide) for Injection was reported. A 22-year-old obstetric patient received 5mg/kg of
896 RAPLON™ during rapid sequence induction for Cesarean section. The patient did not meet
897 extubating criteria until more than two hours after administration of RAPLON™. Complete
898 recovery was reached 19 minutes after the sixth dose of 1.0 mg of neostigmine. There was no
899 evidence of recurarization or respiratory distress in the recovery room. The premature newborn
900 did not demonstrate evidence of neuromuscular weakness.

901
902 Overdosage with neuromuscular blocking agents may result in neuromuscular block extending
903 beyond the time needed for surgery and anesthesia. The primary treatment is maintenance of a
904 patent airway and controlled ventilation until recovery of neuromuscular function is assured.
905

906 ANTAGONISM OF NEUROMUSCULAR BLOCKADE

907
908 THE USE OF A NERVE STIMULATOR TO DOCUMENT RECOVERY AND ANTAGONISM OF
909 NEUROMUSCULAR BLOCKADE IS RECOMMENDED. Patients should be evaluated for
910 adequate clinical evidence of antagonism, e.g., 5 second head lift, ventilation, and upper airway
911 maintenance. Ventilation must be supported until recovery of normal respiration is assured. A 1.5
912 mg/kg or 2.5 mg/kg dose of RAPLON™ (rapacuronium bromide) for Injection may be reversed 2
913 minutes after administration with neostigmine 50 mcg/kg in order to reduce the duration by
914 approximately 50%.
915

916 Antagonism may be delayed in the presence of debilitation, carcinomatosis, and concomitant use
917 of certain broad-spectrum antibiotics, anesthetic agents, and other drugs that enhance
918 neuromuscular blockade or separately cause respiratory depression. Under such circumstances,
919 clinical management is the same as that for prolonged neuromuscular blockade.

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DOSAGE AND ADMINISTRATION

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Dose for Tracheal Intubation

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The recommended initial dose of RAPLON™ (rapacuronium bromide) for Injection in adult and geriatric patients is 1.5 mg/kg for short surgical procedures. In US and European studies, acceptable intubation scores were present in at least 85% of patients within 60 seconds after administration of 1.5 mg/kg of RAPLON™. Maximum block was achieved in most patients by 90 seconds. This dose had a mean clinical duration of approximately 15 minutes. In patients undergoing Cesarean section, the recommended RAPLON™ intubating dose, with thiopental induction, is 2.5 mg/kg.

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Repeat Dosing in Adults (Bolus) Following an intubating dose of 1.5 mg/kg, up to three maintenance doses of 0.50 mg/kg of RAPLON (rapacuronium bromide) for Injection, administered at 25% recovery of control T1 provided a mean clinical duration of 12 – 16 minutes under opioid/nitrous oxide/oxygen anesthesia. The duration of neuromuscular blockade was noted to increase with each additional dose. Repeat dosing should always be guided based on the clinical duration of the previous dose and should not be administered until recovery of neuromuscular function is evident (See PRECAUTIONS, Repeat Dosing).

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Use in Pediatrics

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Initial doses of RAPLON™ of 2 mg/kg intravenously in pediatric patients (ages 1 month to 12 years) under halothane anesthesia produced acceptable intubating conditions within 60 seconds. Mean maximum block occurred within 90 seconds in most pediatric patients and had a mean clinical duration of approximately 15 minutes. When administration is being considered for patients 13 to 17 years of age, clinicians should consider the physical maturity, height, and weight of the patient in determining the dose of RAPLON™. The adult (1.5 mg/kg), pediatric (2.0 mg/kg), and Cesarean Section (2.5 mg/kg) dosing recommendations may serve as a general guideline in determining an intubating dose in this age group.

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Use in Geriatrics

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The clinical duration of RAPLON™ (rapacuronium bromide) for Injection is not prolonged in geriatric patients at a dose of 1.5 mg/kg, and the median spontaneous recovery time is not different from that in other adults. No dosage adjustment is recommended in elderly patients.

969

Compatibility
RAPLON™ (rapacuronium bromide) for Injection is compatible in solution with:

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0.9% NaCl solution	sterile water for injection
5% dextrose in water	lactated Ringers
5% dextrose in saline	bacteriostatic water for injection

974
975 Use within 24 hours of mixing with the above solutions. Prepared solutions may be stored at room
976 temperature.

977
978 Studies have shown that RAPLON™ is physically compatible when mixed with the following
979 drugs:

980		
981	alfentanil	lidocaine
982	aminophylline (compatible if used within 4 hours)	methohexital
983	atropine sulfate	metoclopramide
984	ceftazidime (compatible if used within 4 hours)	midazolam
985	droperidol	morphine
986	epinephrine	potassium chloride
987	fentanyl	propranolol
988	gentamycin	ranitidine
989	glycopyrrolate	remifentanil
990	heparin sulfate	sufentanil
991	ketamine	verapamil
992	labetalol	

993
994 RAPLON™ is physically incompatible when mixed with the following drugs:

995
996 cefuroxime
997 danaparoid sodium
998 diazepam
999 nitroglycerin
1000 thiopental

1001
1002 Parenteral drug products should be inspected visually for particulate matter and clarity prior to
1003 administration, whenever solution and container permit. Do not use solution if particulate matter is
1004 present.

1005
1006 **Safety and Handling**

1007
1008 There is no specific work-exposure limit for RAPLON™ (rapacuronium bromide) for Injection. In
1009 case of eye contact, flush with water for at least 10 minutes.

1010
1011 **HOW SUPPLIED**

1012
1013 RAPLON™ (rapacuronium bromide) for Injection is available in the following forms:

1014
1015 5-mL vials containing 100 mg of rapacuronium bromide base and when
1016 reconstituted to 5 mL with sterile water for injection or bacteriostatic water for
1017 injection providing 20 mg of rapacuronium bromide base per milliliter (20 mg/mL)
1018 at a pH of 4.0

1019 Boxes of 10 NDC No. 0052-0490-15

1020
1021 10-mL vials containing 200 mg of rapacuronium bromide base and when
1022 reconstituted to 10 mL with sterile water for injection or bacteriostatic water for
1023 injection providing 20 mg of rapacuronium bromide base per milliliter (20 mg/mL)
1024 at a pH of 4.0

1025 Boxes of 10 NDC No. 0052-0490-16

1026
1027 The packaging of this product contains no natural rubber (latex).

1028

1029 **Storage**

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1031 Store at 2-25° C (36-77° F).

1032

1033 **After reconstitution**

1034

1035 When reconstituted with sterile water for injection or other compatible I.V. solutions, keep vial at
1036 room temperature or refrigerated 2-25° C (36-77° F) and use within 24 hours. Discard unused
1037 portion. Single use only.

1038

1039 When reconstituted with bacteriostatic water for injection, keep vial at room temperature or
1040 refrigerated 2-25° C (36-77° F) and use within 24 hours. Bacteriostatic water for injection
1041 CONTAINS BENZYL ALCOHOL, WHICH IS NOT INTENDED FOR USE IN NEWBORNS.

1042

1043 **R only**

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Organon Inc.
West Orange, NJ 07052