

Perioperative Management of Hypertension

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CASE

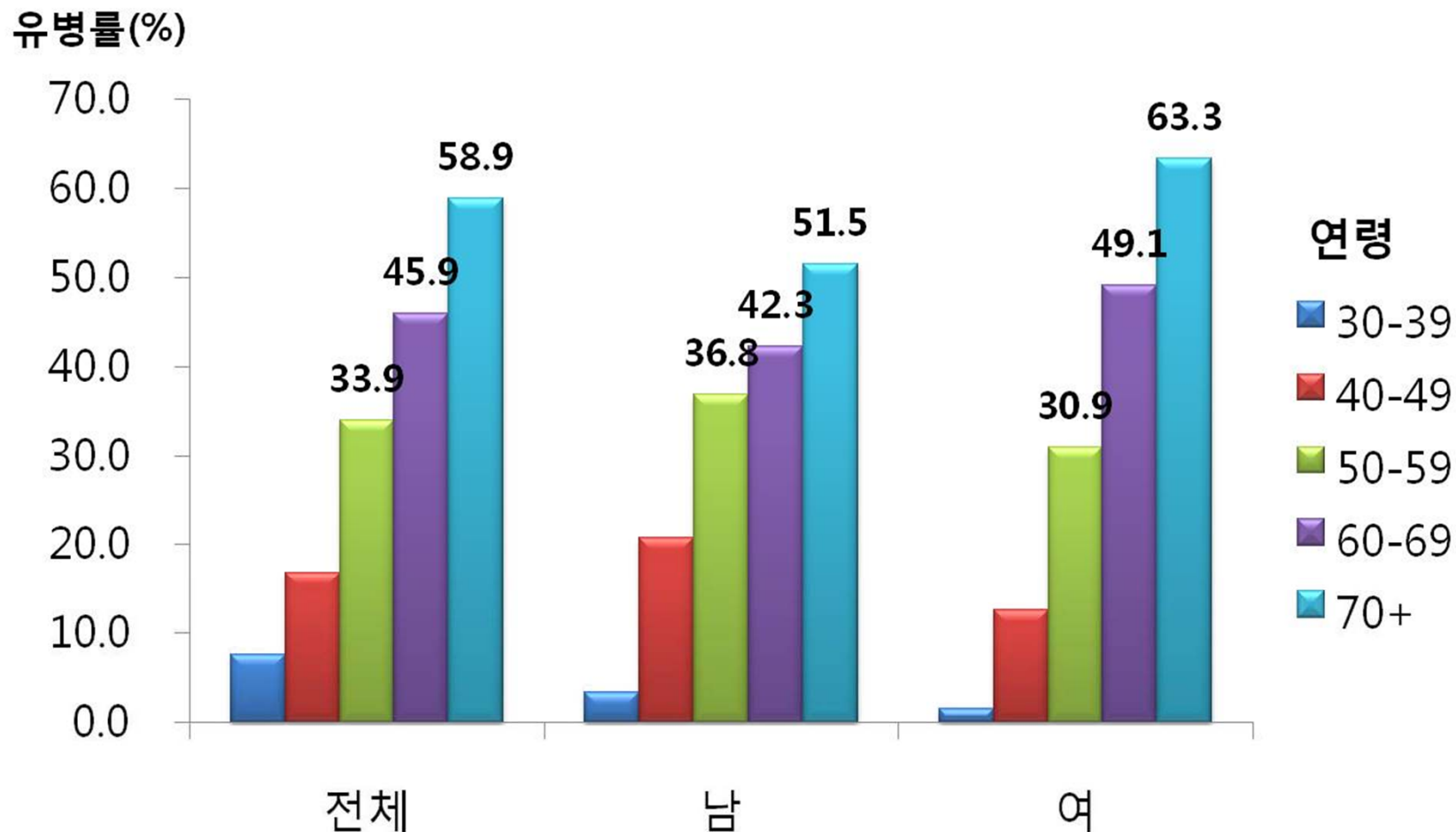
- **#1)** M/45 BP 180/115 mmHg, HR 98 bpm
 - Adm. for femur shaft open fracture op. d/t TA
 - HTN(+) – 6 yrs, no medication
 - No other medical history

- **#2)** M/75 BP 100/75 mmHg, HR 92 bpm
 - Adm. for prostate cancer op.
 - HTN(+) – 15 yrs, amlodipine, valsartan, diuretics
 - Hx. of DM (insulin pump), CRI (Cr 2.8mg/dL), stroke (+)

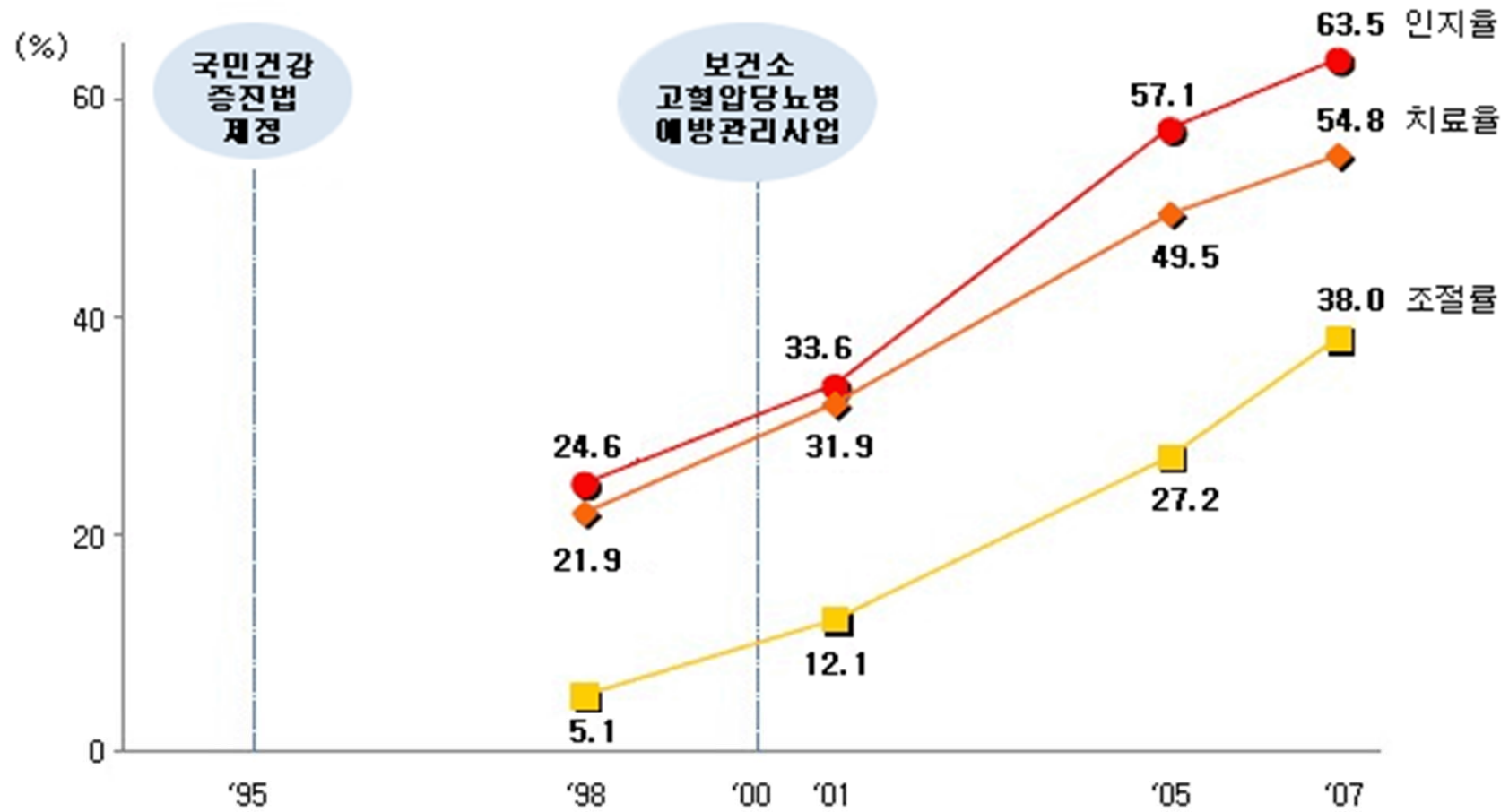
Introduction

- Hypertension is **most common** medical reason for postponing surgery

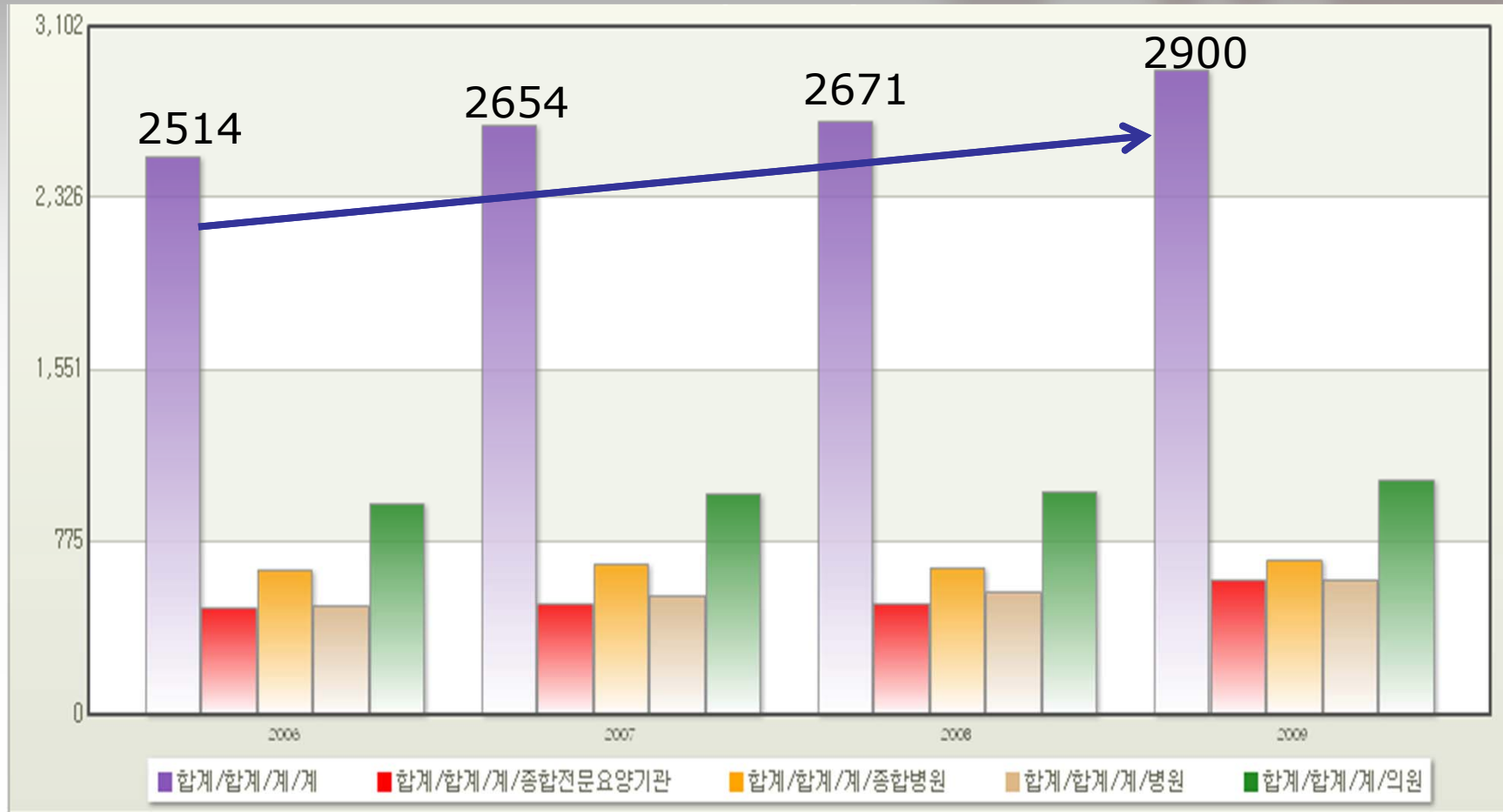
Epidemiology of hypertension



< 고혈압 관리현황 >



인구 10만명당 수술인원 현황



Step 1

Need for emergency noncardiac surgery?

Waiting room

Perioperative surveillance and postoperative risk stratification and risk factor management

Step 2

Table 2. Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery (Class I, Level of Evidence: B)

Condition	Examples
Unstable coronary syndromes	Unstable or severe angina* (CCS class III or IV) [†] Recent MI [‡]
Decompensated HF (NYHA functional class IV; worsening or new-onset HF) Significant arrhythmias	High-grade atrioventricular block Mobitz II atrioventricular block

Step 3

Step 4

Step

3 or more clinical risk factors^{||}

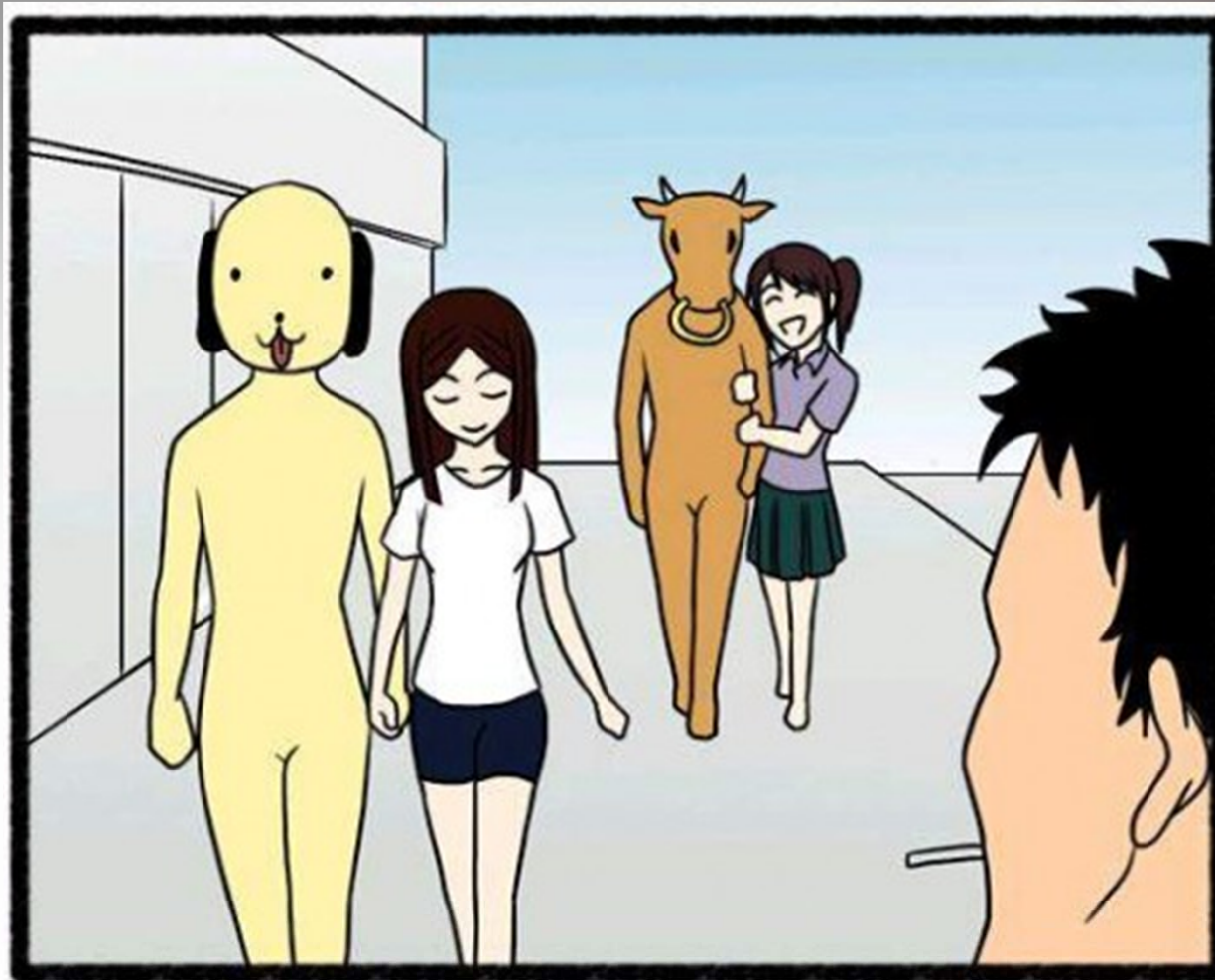
Clinical risk factors;
IHD, compensated or prior HF, DM, renal insufficiency, and cerebrovascular disease

than 1.0 cm², or symptomatic)
Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)

Vascular surgery
Class IIa, LOE B
Consider testing if it will change management[¶]

Proceed with planned surgery with HR control[¶] (Class IIa, LOE B) or consider noninvasive testing (Class IIb, LOE B) if it will change management

No clinical risk factors^{||}
Class I, LOE B
Proceed with planned surgery[†]



고혈압과는 상관없이 수술?????

Hypertension and Cardiac Risk

- Hypertension has been associated with the development of CAD, CHF, LV hypertrophy, renal insufficiency, cerebrovascular disease.

Pre-Hypertension

($>120/80 <140/90$)

Pre-Hypertension is common: 40%

Associated with increased risk:

	OR	CI
CV death	1.58	1.12-2.21
MI	1.76	1.40-2.22
Stroke	1.93	1.49-2.50
CHF	1.36	1.05-1.77

Pulse Pressure and Cardiac Risk

Framingham Study (30 Year Follow-Up)

Pulse Pressure (mm Hg)	Rate /1,000			
	35-64 yrs		65-94yrs	
	Women	Men	Women	Men
2-39	9	4	2	17
40-49	13	6	16	19
50-59	16	7	32	22
60-69	22	10	39	25
70-182	33	16	58	32
Regression	0.024	0.025	0.024	0.014
Risk factor	0.018	0.019	0.021	0.010

Preoperative Hypertension

- History of hypertension increased postoperative death to **3.8 times** than that of normotensives.

Browner WS, et al. JAMA 1992;268:252

- Preoperative hypertension was **4 times** more cardiac mortality than that of age-matched control.

Preoperative Hypertension

- Stage 1 or 2 hypertension (SBP <180 mmHg and DBP <110 mmHg) is **not** an independent risk factor for perioperative cardiovascular complications

Preoperative Hypertension

- One prospective randomized 989 patients for **stage 3** hypertension (DBP 110~130 mmHg) without clinical risk factors
: compared delayed operation with immediate BP control with nifedipine
→ **No** significant differences in postoperative complications

ACC/AHA Perioperative Guideline

- Stage 1 or 2 hypertension
 - ➔ no need to delay surgery or escalation in medical therapy
- In stage 3 hypertension
 - ➔ antihypertensive therapy should be weighed against the risk of delaying surgery

Blood pressure response during anesthesia

- **Sympathetic activation** (during induction and awakening)

normotensives → BP↑ 20~30 mmHg

HR↑ 15~20 bpm

hypertensives → BP↑ ~90 mmHg

HR↑ ~40 bpm

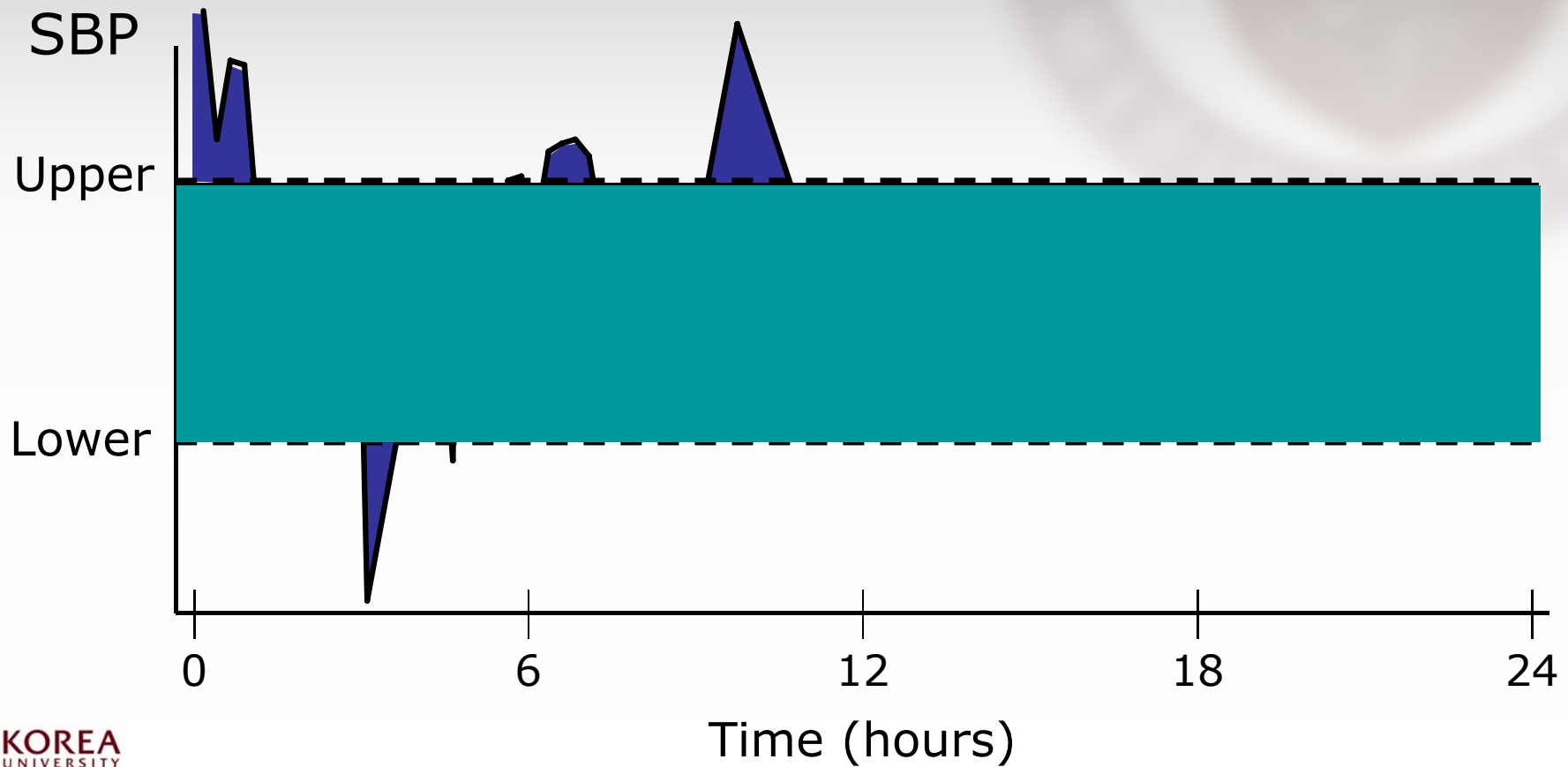
More prominent in untreated

- **Hypotension** **hypertensive patients**

– effect of anesthetics, inhibition of sympathetic tone,
loss of vasoreceptor reflex

ECLIPSE Secondary Endpoint

Systolic Blood Pressure Control Over 24 Hours



Adverse Events & BP Control

	AUC Quartile	All agents* n/N (%)
Death	1st	7/380 (1.8)
	4th	16/378 (4.2)
MI	1st	6/380 (1.6)
	4th	11/378 (2.9)
Stroke	1st	4/380 (1.1)
	4th	6/378 (1.6)
Renal	1st	24/380 (6.3)
	4th	39/378 (10.3)

*N=1512

SBP range of 75–145 (pre & post-op), 65-135 (intra-op)

Intra- and postoperative hypertension

- Intraoperative BP and HR lability **increased** the risk for cardiac ischemia, heart failure, stroke, neurocognitive dysfunction, and bleeding.

Hypertensive Emergency

(>180/110 mmHg)

- Pain, agitation, hypercarbia, hypoxia, hypervolemia, bladder distension
- Hx. of HTN, resume antihypertensive medication

Treatment of Hypertensive Emergency

- Consider parenteral antihypertensive agents

→ during initial 30~60min:

↓ DBP by 10~15% or to 110 mmHg

→ next 24~48hr:

↓ BP to baseline level

Parenteral Agents

Agent	dosing	Time to action	duration
Nitroprusside	0.25-10 $\mu\text{g}/\text{kg}/\text{min}$	immediately	2-5 min
Esmolol	50-200 $\mu\text{g}/\text{kg}/\text{min}$	1-2 min	10-20 min
Nitroglycerine	5-100 $\mu\text{g}/\text{kg}/\text{min}$	2-5 min	3-10 min
labetalol	20-80mg/IV or 2mg/min	5 min	3-6 hr
Hydralazine	5-10 mg/IV q 20 min	10-20 min	4-12 hr

Perioperative Antihypertensive Agents

Beta-blockers

(who are currently taking)

- Reduce intraoperative MI & death, and may prevent arrhythmia
- Acute → should be continued including day of surgery (Class **Ic**)
mo

Determine Risk Score

Assign 1 Point for Each of the Following Characteristics: Age ≥ 70 Years, Current Angina, Prior Myocardial Infarction, Congestive Heart Failure, Prior Cerebrovascular Event, Diabetes Mellitus, and Renal Failure



Score = 0 (28%)

0 < Score < 3 (55%)

Score ≥ 3 (17%)

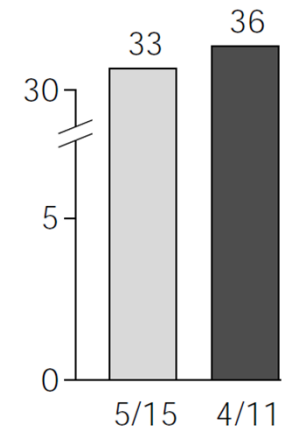
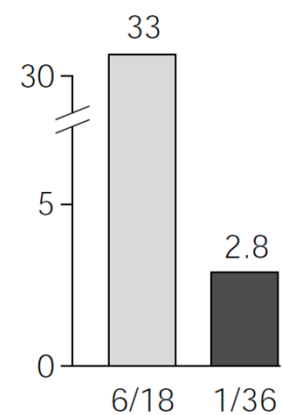
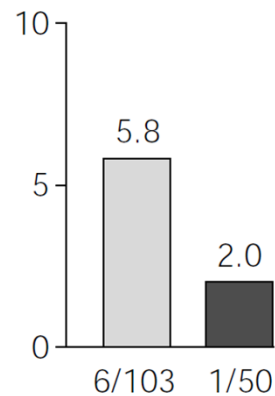
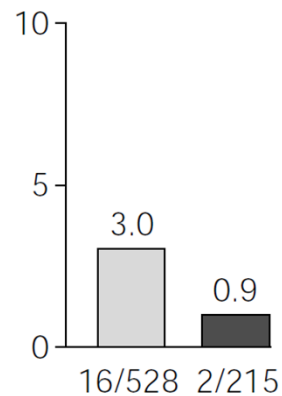
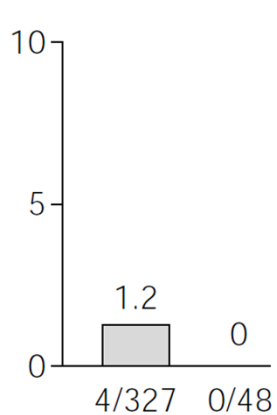
Dobutamine Stress Echocardiography (DSE)

No New Wall-Motion Abnormalities (11%)

New Wall-Motion Abnormalities in 1-4 Segments (4%)

New Wall-Motion Abnormalities in ≥ 5 Segments (2%)

MEK
Cardiac Complications, %



Beta-blockers

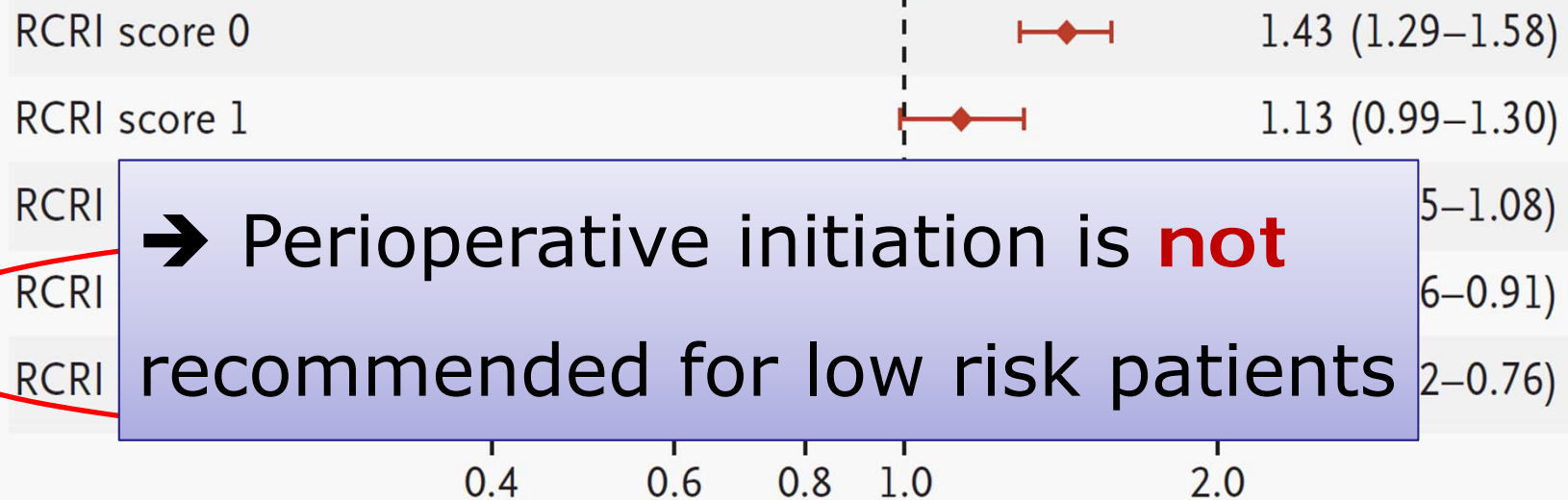
Entire Study Cohort

RCRI score 0	1.36 (1.27–1.45)
Hypertension	0.96 (0.82–1.13)
RCRI score 1	1.09 (1.01–1.19)
Diabetes	1.28 (1.10–1.50)
Ischemic heart disease	1.12 (0.95–1.31)
Renal insufficiency	1.03 (0.82–1.23)
Cerebrovascular disease	1.01 (0.76–1.35)
High-risk surgery	0.94 (0.84–1.05)
RCRI score 2	0.88 (0.80–0.98)
RCRI score 3	0.71 (0.63–0.80)
RCRI score ≥ 4	0.58 (0.50–0.67)

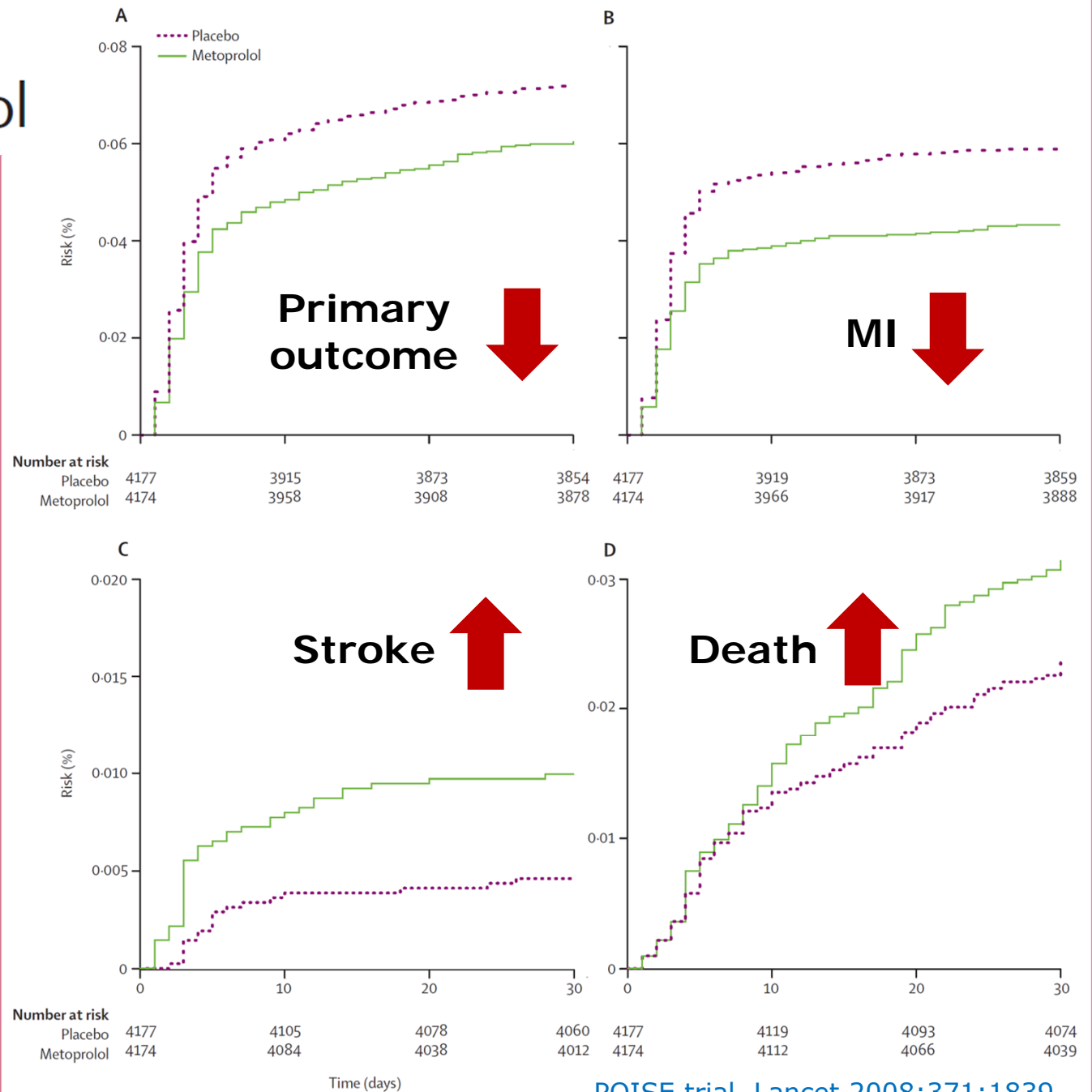
Odds Ratio for Death in the Hospital
(95% confidence interval)

Beta-blockers (who are not currently taking)

Propensity-Matched Cohort (n=335,922)



..... Placebo
——— Metoprolol
(N=8351)



Beta-blockers (who are not currently taking)

Studies	n	Odd ratio for stroke (CI)	Statistical significance
POISE (metoprolol)	8351	2.2 (1.3-3.8)	Significant
DECREASE I, II, IV (bisoprolol)	3884	1.16 (0.4-3.4)	Not significant

→ with a low-dose bisoprolol started ≥ 30 days before surgery, No association with stroke.

Pete blockers



ACEi or ARB

- Blunt the compensatory activation of the renin-angiotensin system during surgery
→ prolonged hypotension

HTN: continue to the day of surgery

HF or low BP: discontinue morning dose

Calcium channel blockers

- Associated with trends toward **reduced** MI/death (diltiazem), atrial arrhythmia (verapamil)
- No serious interaction with anesthetic agent
- Withdrawal syndrome is not typical
- Conflicting evidence on increasing risk of **bleeding**

Continue up to and including
day of surgery

Diuretics

- Both loop and thiazide-type diuretics:

- Hypokalemia

- arrhythmia, paralytic ileus

- Continue up to day of surgery,
rela but discontinue morning dose

- Hypovolemia

- Hypotension due to systemic vasodilation

Alpha 2 agonist

- Clonidine, methyldopa, guanfacine
- May improve perioperative outcomes but rebound hypertension when discontinued

→ continue up to and including day of surgery

→ **Not available** in Korea

Herbal medication



Ephedra (마황)



Garlic (마늘)



Gingko (은행)

Herbal agents should be discontinued at least one week

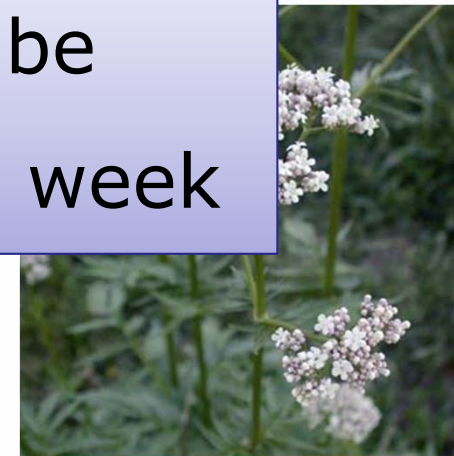


KOREA
UNIVERSITY
MEDICAL CENTER

Ginseng (인삼)



St John's Wort
(고추나물)



Valerian (쥐오줌풀)

Case Discussion #1

- #1) M/45 BP 180/115 mmHg, HR 98 bpm
 - Adm. for femur shaft open fracture op. d/t TA
 - HTN(+) – 6 yrs, no medication
 - No other medical history

Hypertensive urgency

No cardiac risk

Emergency op Ix.

→ Parenteral Agents

Case Discussion #2

- #2) M/75 BP 100/75 mmHg, HR 92 bpm
 - Adm. for prostate cancer op.
 - HTN(+) – 15 yrs, amlodipine, valsartan, lasix
 - Hx. of DM (insulin pump), CRI (Cr 2.8mg/dL), stroke (+)

Three cardiac risks

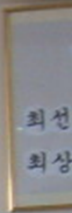
- add beta-blocker (???)
- Discontinue morning dose of diuretics & ARB

Summary (I)

- Perioperative hypertensives are very very common
- Well-controlled hypertensives are less likely to experience perioperative complications
- In stage 1 or 2 hypertensives without end-organ damage, it is not necessary to postpone surgery

Summary (II)

- In stage 3 hypertensives ($>180/110$ mmHg), elective surgery should be postponed.
 - in emergency operation, consider parenteral antihypertensive agents
- Consider other cardiovascular risk factors



$y = a^x \quad (a > 1, a \neq 1)$
 $\Rightarrow y' = x \ln a \cdot a^x$
 $y = e^x \Rightarrow y' = e^x$

$y = a^x \Rightarrow y' = a^x \ln a$
 $y = x^a \Rightarrow y' = a x^{a-1}$
 $y = x^2 \Rightarrow y' = 2x$
 $y = x^3 \Rightarrow y' = 3x^2$
 $y = x^n \Rightarrow y' = n x^{n-1}$

$y = e^{ax} \Rightarrow y' = a e^{ax}$
 $y = e^{ax} \cos x \Rightarrow y' = a e^{ax} \cos x - e^{ax} \sin x$
 $y = e^{ax} \sin x \Rightarrow y' = a e^{ax} \sin x + e^{ax} \cos x$

$y = \frac{1}{x} \Rightarrow y' = -\frac{1}{x^2}$
 $y = \frac{1}{x^2} \Rightarrow y' = -\frac{2}{x^3}$
 $y = \frac{1}{x^n} \Rightarrow y' = -\frac{n}{x^{n+1}}$

$y = \sqrt{x} \Rightarrow y' = \frac{1}{2\sqrt{x}}$
 $y = x^{\frac{1}{2}} \Rightarrow y' = \frac{1}{2} x^{-\frac{1}{2}}$

$y = \ln x \Rightarrow y' = \frac{1}{x}$
 $y = \ln(ax) \Rightarrow y' = \frac{1}{ax} \cdot a = \frac{1}{x}$

$y = \log_a x \Rightarrow y' = \frac{1}{x \ln a}$
 $y = \log_a(ax) \Rightarrow y' = \frac{1}{ax \ln a} \cdot a = \frac{1}{x \ln a}$

$y = \sin x \Rightarrow y' = \cos x$
 $y = \cos x \Rightarrow y' = -\sin x$
 $y = \tan x \Rightarrow y' = \sec^2 x$
 $y = \sec x \Rightarrow y' = \sec x \tan x$
 $y = \csc x \Rightarrow y' = -\csc x \cot x$
 $y = \cot x \Rightarrow y' = -\csc^2 x$

$y = e^{-ax} \Rightarrow y' = -a e^{-ax}$
 $y = e^{-ax} \cos x \Rightarrow y' = -a e^{-ax} \cos x - e^{-ax} \sin x$
 $y = e^{-ax} \sin x \Rightarrow y' = -a e^{-ax} \sin x + e^{-ax} \cos x$

$y = \frac{1}{\sqrt{x}} \Rightarrow y' = -\frac{1}{2x^{\frac{3}{2}}}$
 $y = x^{-\frac{1}{2}} \Rightarrow y' = -\frac{1}{2} x^{-\frac{3}{2}}$

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$y = \frac{1}{x^{68}} \Rightarrow y' = -\frac{68}{x^{69}}$
 $y = x^{-68} \Rightarrow y' = -68x^{-69}$

$y = \frac{1}{x^{69}} \Rightarrow y' = -\frac{69}{x^{70}}$
 $y = x^{-69} \Rightarrow y' = -69x^{-70}$

$y = \frac{1}{x^{70}} \Rightarrow y' = -\frac{70}{x^{71}}$
 $y = x^{-70} \Rightarrow y' = -70x^{-71}$

$y = \frac{1}{x^{71}} \Rightarrow y' = -\frac{71}{x^{72}}$
 $y = x^{-71} \Rightarrow y' = -71x^{-72}$

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 $y = x^{-72} \Rightarrow y' = -72x^{-73}$

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 $y = x^{-98} \Rightarrow y' = -98x^{-99}$

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 $y = x^{-99} \Rightarrow y' = -99x^{-100}$

$y = \frac{1}{x^{100}} \Rightarrow y' = -\frac{100}{x^{101}}$
 $y = x^{-100} \Rightarrow y' = -100x^{-101}$



Back-up

Preoperative Hypertension

Preoperative hypertension is associated
with perioperative hypo-/hypertension and
tachy-/bradycardia

Forrest JB, et al. *Anesthesiology* 1992;76:3

However, hypotension and BP lability has
not been shown to be a significant predictor
of myocardial ischemia or infarction

Hypertensive Crisis

Acute intraoperative elevation in BP ($>20\%$) or postoperative HTN (SBP ≥ 190 and/or DBP ≥ 110 mmHg)

→ incidence: 4~35%

→ if, untreated, increase risk for bleeding, CVA, MI (esp. F/Hx. of cerebral hemorrhage)

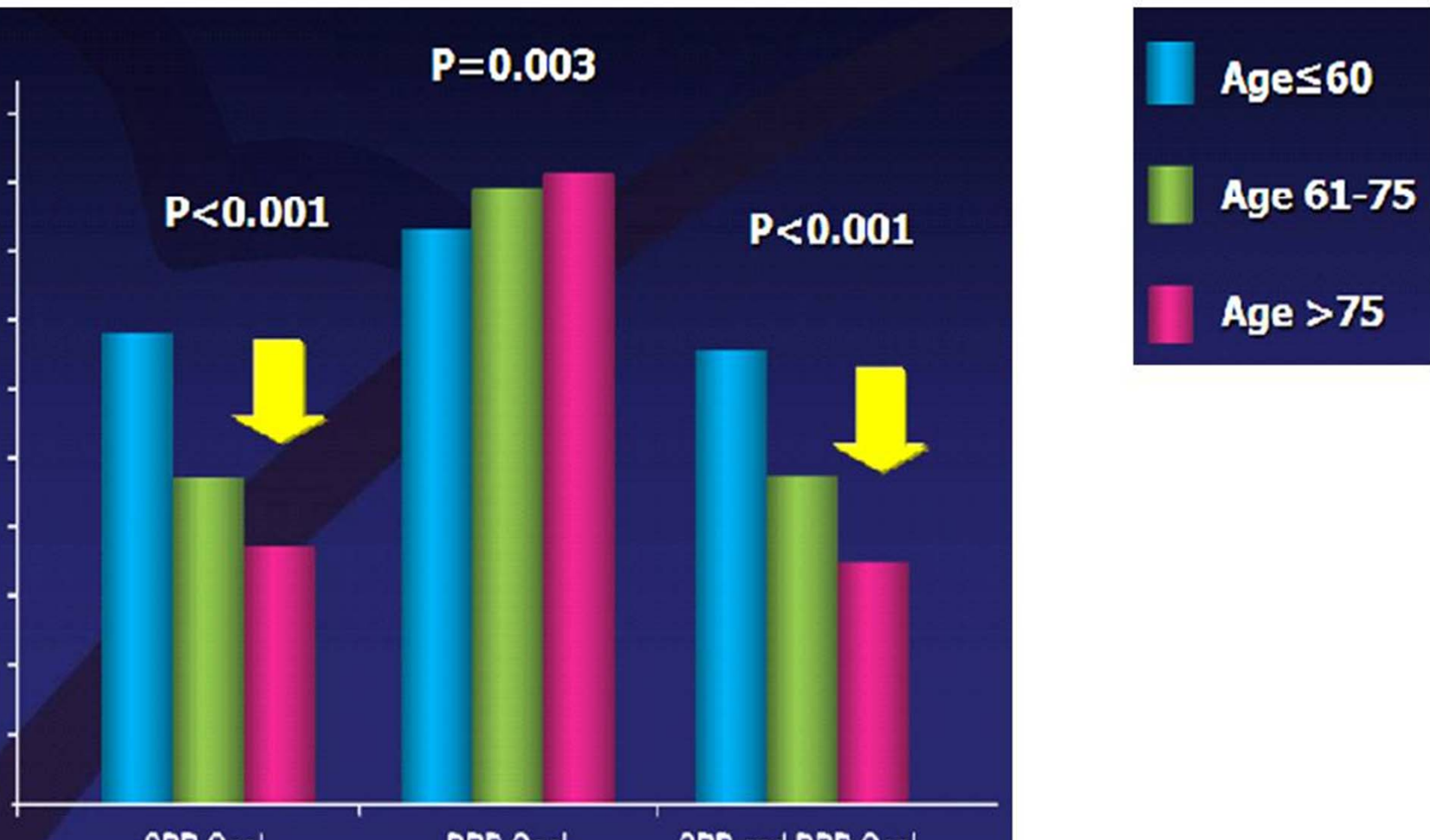
→ Hx. of hypertension is common

Treatment

Treatment of perioperative hypertension is considerably **different** than that of chronic hypertension

- prevention
- antihypertensive medication starting several days before surgery
- should be continued during the perioperative

고혈압 인구에서 목표혈압 도달율



Preoperative Hypertension

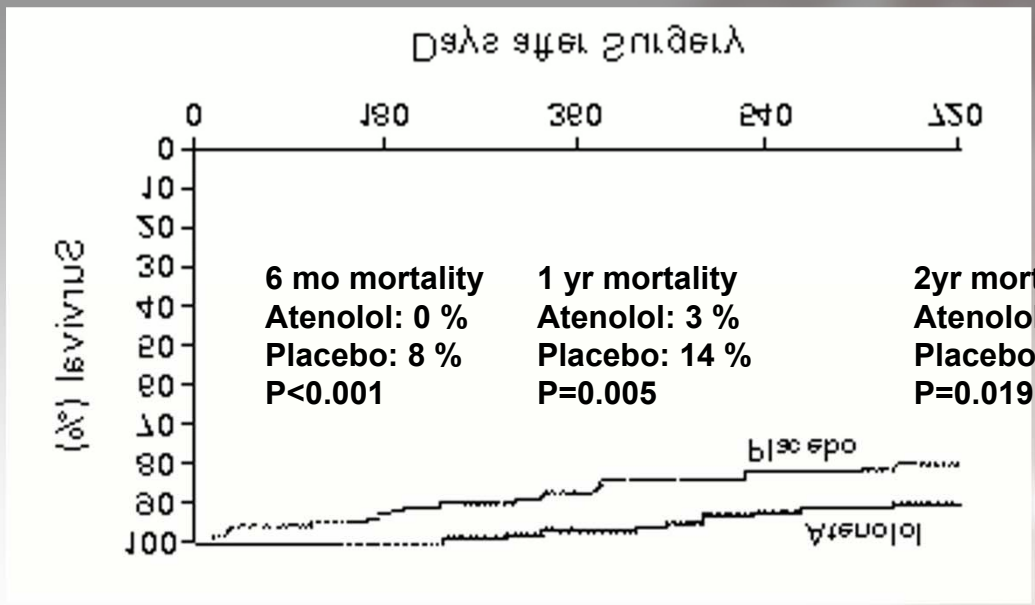
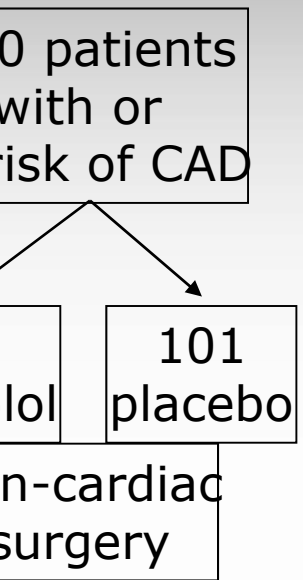
Preoperative hypertension is frequently not an emergency → typically does not involve end organ damage and enough time to control

Control of BP preoperatively may help reduce the tendency to perioperative ischemia

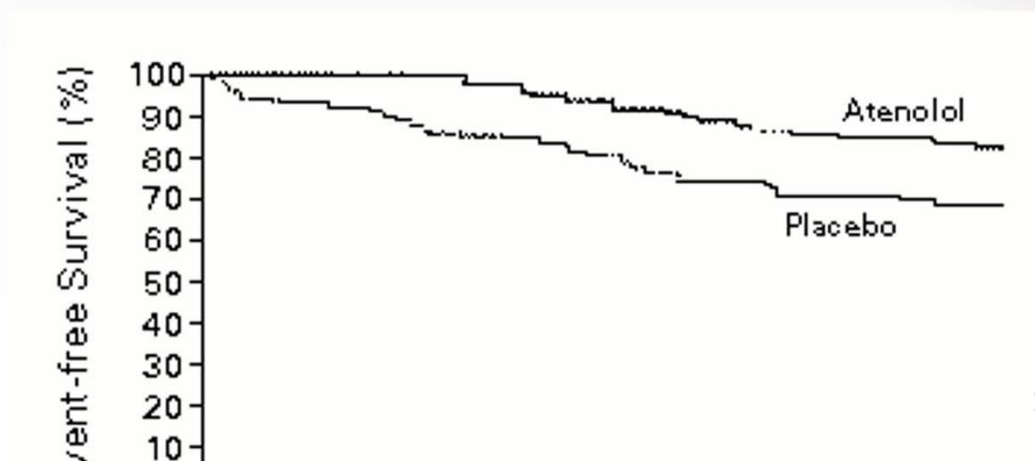
Predictors of Mortality

	P-Value	OR	95% CI
Operative Duration (hour)	<0.0001	1.517	[1.240, 1.856]
Age (year)	0.0003	1.070	[1.031, 1.110]
Preoperative Creatinine \geq 1.2 mg/dL	0.0031	2.670	[1.392, 5.122]
Preoperative Creatinine (area outside the range)	0.0069	1.003	[1.001, 1.004]
Additional surgical procedures	0.0089	2.409	[1.246, 4.655]
Preoperative Hgb (g/dL)	0.0135	0.824	[0.707, 0.961]
Preoperative SBP >160 or DBP > 105	0.0228	2.386	[1.147, 4.963]
Preoperative COPD	0.0228	2.326	[1.125, 4.812]
Preoperative f... 1 M...	0.0010	2.107	[1.070, 4.107]

of atenolol on mortality and cardiovascular morbidity, post op.



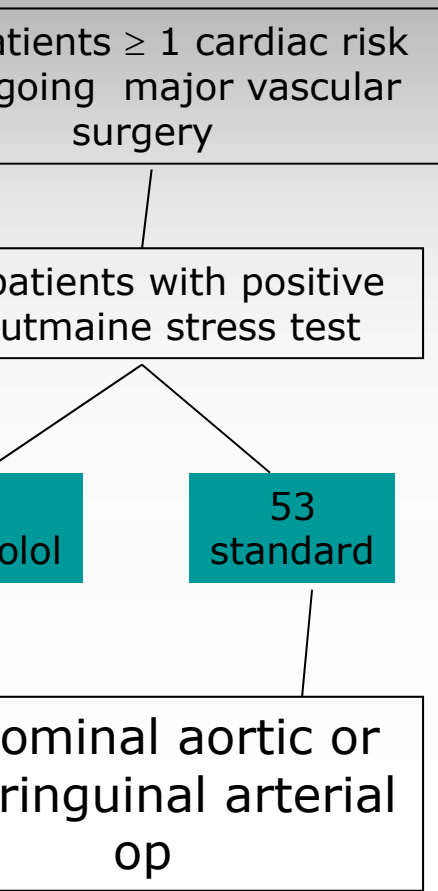
Survival



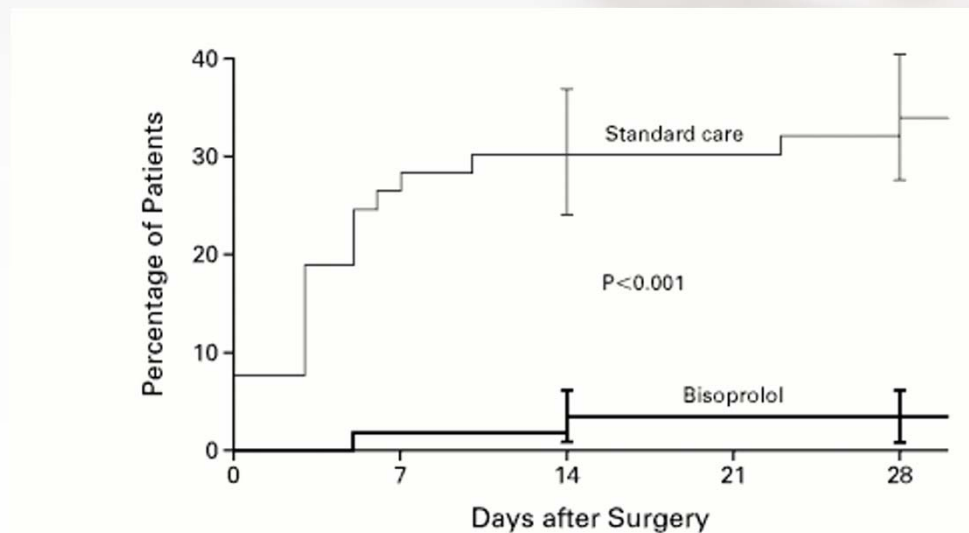
Event free survival

Effect of bisoprolol on perioperative mortality and MI

DECREASE study

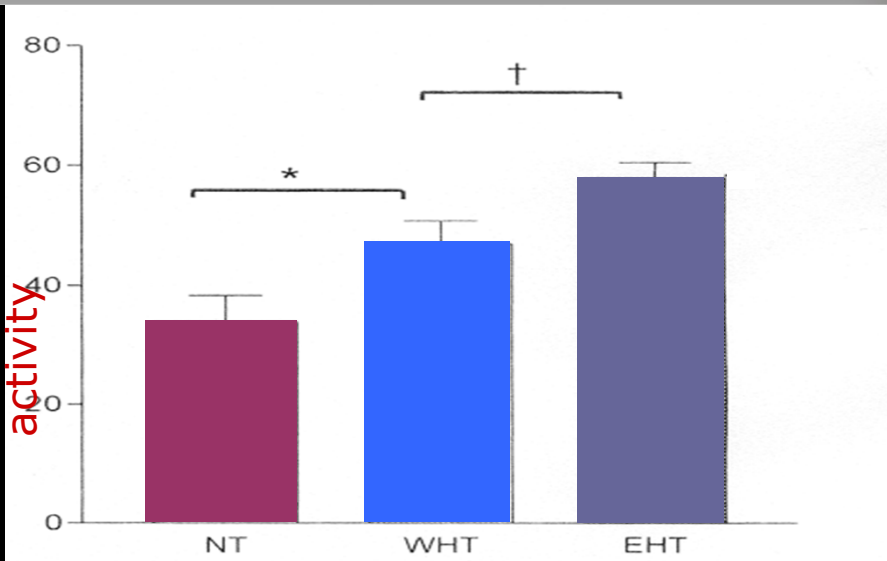


	bisoprolol	standard	p
Death	2/59 (3.4 %)	9/53 (17 %)	0.02
Nonfatal MI	0	9/53 (17 %)	
Combined	3.4 %	34 %	< 0.001

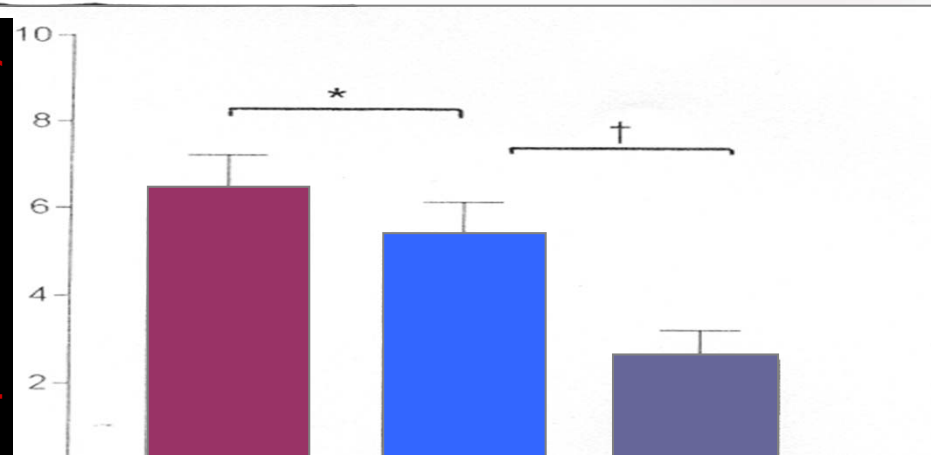


"White Coat" Hypertension

Muscle sympathetic nerve activity



receptor sensitivity

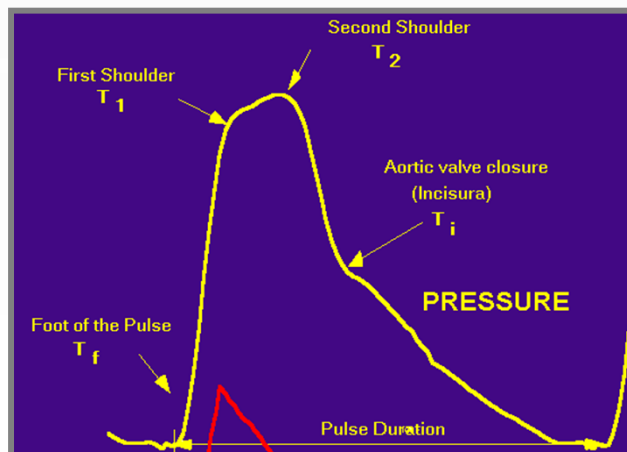
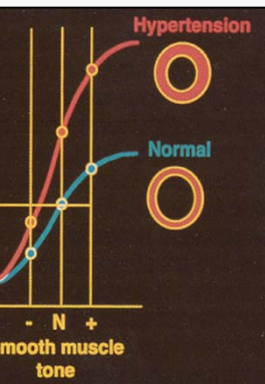


Hypertension: Types and Mechanism

Increase (stress) in arterial wall and vasomotor

} Essential
Secondary

Endocrine, Renal, ICP, coarctation, contraceptives, pregnancy, etc.



Classification

Category	Systolic mmHg		Diastolic mmHg
Optimal	< 120	and	< 75
Normal	< 130	and	< 85
Mild HTN	140-159	or	90-99
Moderate	160-179	or	100-109
Severe	> 180	or	> 110
Isolated SBP HTN	> 140	and	< 90
Pulse Pressure	> 65mmHg		
Orthostatic changes	Hyper response	> 20 mmHg	
	Hypo response	< 20 mmHG	

LIPSE: Predictors of postoperative renal dysfunction

512 undergoing cardiac surgery

	Odds ratio (95% CI)	P†
Preoperative serum Cr ≥ 1.2 mg/dL	4.71 (3.067-7.235)	<0.0001
Black (African American)	2.166 (1.19-3.943)	0.0114
Primary CABG + valve	1.957 (1.158-3.307)	0.0122
4 th quartile AUC*	1.725 (1.111-2.68)	0.0152
Operative duration (hours)	1.263 (1.054-1.515)	0.0116
Age (years)	1.037 (1.013-1.062)	0.0023
	1.05 (1.016-1.086)	0.0042

Secondary Hypertension

Pheochromocytoma

Renal artery stenosis

Coarctation of aorta

Hyperaldosteronism

GLOBAL PRIDE

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감사합니다

