How to manage BP in CKD patients (ND and D)

JM Krzesinski

Department Nephrology-Dialysis-Transplantation

CHU Liège- ULg

Table 27 | Prevalence of CKD complications by GFR category* derived from CKD cohorts

Complication	GFR category (ml/min/1.73 m^2)					Reference
	≥90	60-89	45-59	30-44	<30	
Anemia[1]	4.0%	4.7%	12.3%	22.7%	51.5%	
Hypertension[2]	18.3%	41.0%	71.8%	78.3%	82.1%	
25(OH) Vit D deficiency[3]	14.1%	9.1%	10.7%		27.2%	
Acidosis[4]	11.2%	8.4%	9.4%	18.1%	31.5%	
Hyperphosphatemia[5]	7.2%	7.4%	9.2%	9.3%	23.0%	
Hypoalbuminemia[6]	1.0%	1.3%	2.8%	9.0%	7.5%	
Hyperparathyroidism[7]	5.5%	9.4%	23.0%	44.0%	72.5%	

Kidney International Supplements (2013) **3**, 73–90

American Journal of Kidney Diseases, Vol 55, No 3 (March), 2010: pp 415-418

Table 1. Studies of BP Control and Percentage of Participants Achieving BP < 130/80 mm Hg in CKD

Reference/Year	Study	Location	No. of Participants	BP < 130/80 mm Hg (%)
Peralta et al[1]/2005	NHANES	United States	3,213	37
De Nicola et al[2]/2006	TABLE in CKD	Italy	1,058	12
Sarafidis et al[3]/2008	KEEP	United States	10,813	13
Thilly et al[4]/2009	AVENIR	France	566	25
Muntner et al[5]/2009	CRIC	United States	3,612	46

Note: Studies vary in many factors, including awareness of CKD in patients and clinicians, method of BP measurement, and severity of renal impairment.

Abbreviations: AVENIR, Avantage de la Nephroprotection dans l'Insuffisance Renale; BP, blood pressure; CRIC, Chronic Renal Insufficiency Cohort; CKD, chronic kidney disease; KEEP, Kidney Early Evaluation Program; NHANES III, Third National Health and Nutrition Examination Survey; TABLE, TArget Blood Pressure LEvels in Chronic Kidney Disease.

Blood Pressure Control in CKD Patients: Why Do We Fail to Implement the Guidelines?

Only for ND patients

Kidney International Supplements (2012) **2,**

KDIGO CLINICAL PRACTICE GUIDELINE FOR MANAGEMENT OF BLOOD PRESSURE IN CKD

Important remarks

- No guidelines received the rating 1A
- Only **8 received level 1** recommendations:

- 4 are grade B (particularly BP goal of < or = 140/90 mmHg when no albuminuria)

KDIGO Clinical practice Guideline for the management of *Blood Pressure* in CKD

Adults

- CKD ND without Diabetes Mellitus
- CKD ND with Diabetes Mellitus
- Kidney Transplantation

Children

Elderly

No discussion on High BP in dialysis

Management of High BP in CKD

Lifestyle Modification

2.3: Encourage lifestyle modification in people with CKD ND to lower BP and improve long-term cardiovascular and other outcomes:

2.3.1: We recommend achieving or maintaining a healthy weight (BMI 20 to 25). *(1D)*

2.3.2: We recommend lowering salt intake to <100 mmol (<2.4 g) per day of sodium (corresponding to 6 g of sodium chloride), unless contraindicated. *(1C)*

2.3.3: We recommend undertaking an exercise program compatible with cardiovascular health and tolerance, aiming for at least 30 minutes 5 times per week. *(1D)*

2.3.4: We suggest limiting alcohol intake to no more than two standard drinks per day for men and no more than one standard drink per day for women. *(2D)*

As in the normal population

Chapter 3: Blood pressure management in CKD ND patients without diabetes mellitus

Kidney International Supplements (2012) **2,** 357–362; doi:10.1038/kisup.2012.53

3.1: We recommend that non-diabetic adults with CKD ND and urine albumin excretion <30 mg per 24 hours (or equivalent*) whose office BP is consistently >140 mm Hg systolic or >90 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤140 mm Hg systolic and ≤90 mm Hg diastolic. *(1B)*

BP < 140/90 mmHg

3.2: We suggest that non-diabetic adults with CKD ND and urine albumin excretion of 30 to 300 mg per 24 hours (or equivalent*) whose office BP is consistently >130 mm Hg systolic or >80 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤130 mm Hg systolic and ≤80 mm Hg diastolic. *(2D)*

BP < 130/80 mmHg

3.3: We suggest that non-diabetic adults with CKD ND and urine albumin excretion >300 mg per 24 hours (or equivalent*) whose office BP is consistently >130 mm Hg systolic or >80 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤130 mm Hg systolic and ≤80 mm Hg diastolic. *(2C)*

Systematic Review: Blood Pressure Target in Chronic Kidney Disease and Proteinuria as an Effect Modifier

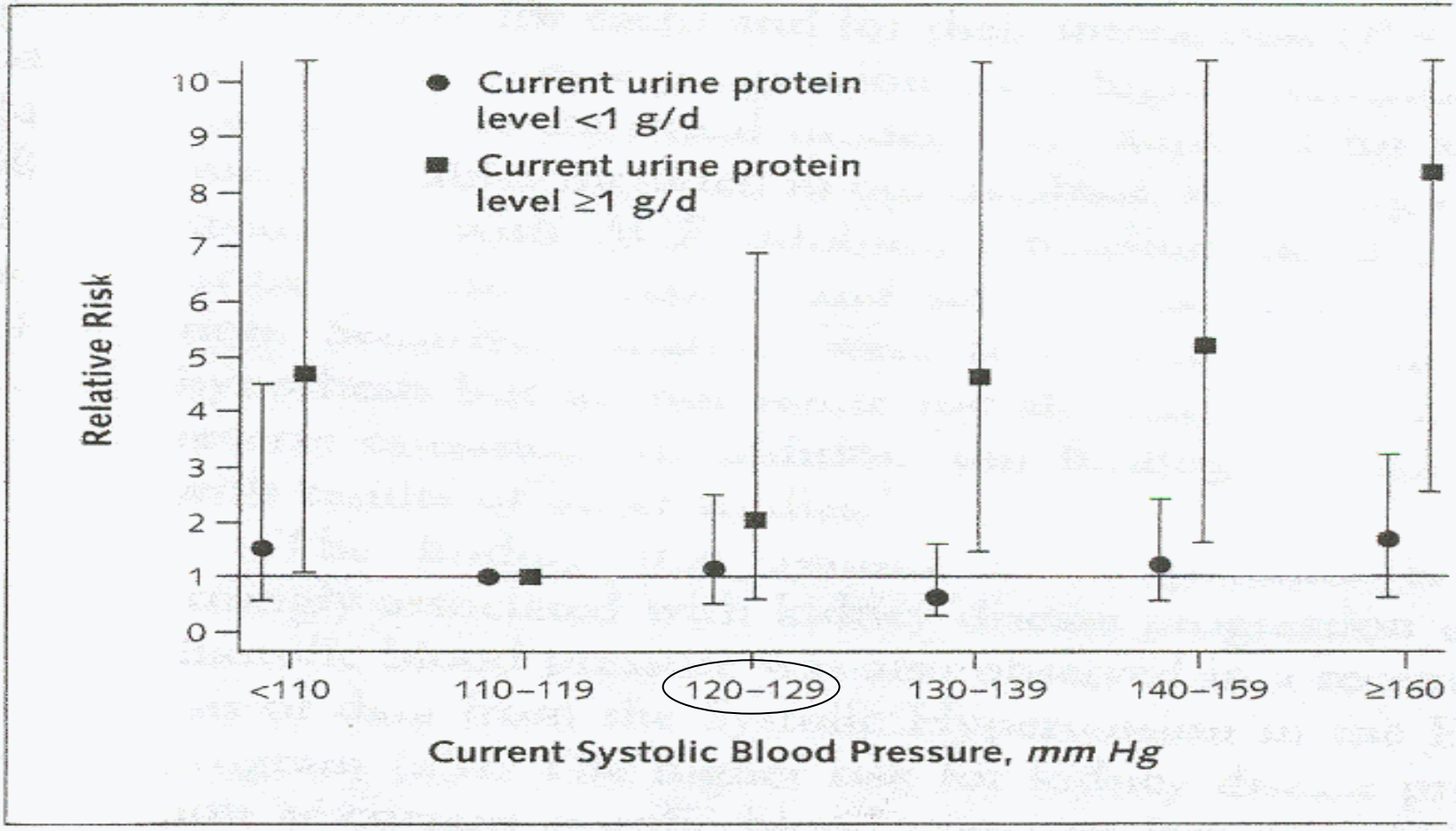
Ann Intern Med. 2011;154:541-548.

Ashish Upadhyay, MD; Amy Earley, BS; Shana M. Haynes, DHSc; and Katrin Uhlig, MD, MS

AASK, MDRD, REIN

This systematic review of RCTs in adults with CKD did not find conclusive evidence favoring a blood pressure target of less than 125/75 to 130/80 mm Hg rather than a target of less than 140/90 mm Hg. After a mean 2- to 4-year follow-up, the main trial results did not show benefit for clinical outcomes (14–19). Only the posttrial follow-up report from the MDRD Study showed benefit of the lower target for kidney failure after about a 6-year follow-up (21). Subgroup analyses by baseline proteinuria levels in the MDRD Study and AASK Trial, but not in the REIN-2 trial, suggest benefit for the lower target in patients with proteinuria greater than 1000 mg/d and urinary protein–creatinine ratio greater than 0.22 g/g, respectively

Figure. Relative risk for kidney disease progression based on current level of systolic blood pressure and current urine protein excretion.

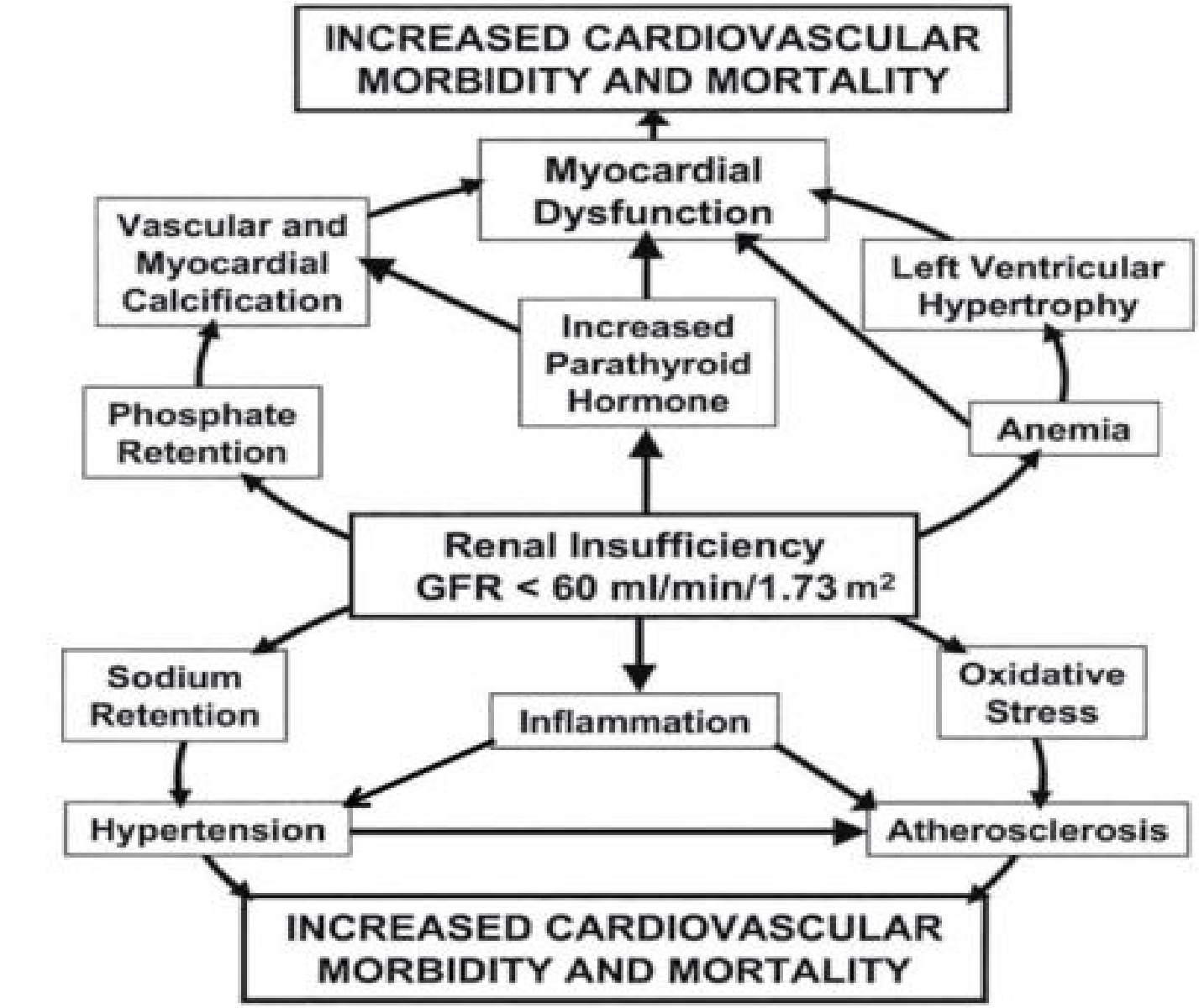


Progression of CKD: role of BP control, Proteinuria and ACEI

Jafar et al. Ann Intern Med 2003

CV protection with lower BP in CKD?

- AASK: no difference between 141/85 vs 128/78 mmHg
- MDRD: no difference between 125/75 vs 140/90 mmHg
- REIN 2: no difference between 130/80 vs 134/82 mmHg



Multiple pathways whereby chronic renal parenchymal disease may increase cardiovascular morbidity and mortality by causing hypertension, atherosclerosis, and/or myocardial dysfunction. GFR = glomerular filtration rate. (From reference 3).

Influence of kidney function and albuminuria on the CV mortality (KDIGO 2013)

Table 5 | GFR categories in CKD

GFR category	GFR (ml/min/1.73 m^2)	Terms
G1	≥90	Normal or high
G2	60–89	Mildly decreased*
G3a	45–59	Mildly to moderately decreased
G3b	30–44	Moderately to severely decreased
G4	15–29	Severely decreased
G5	<15	Kidney failure

Abbreviations: CKD, chronic kidney disease; GFR, glomerular filtration rate.
*Relative to young adult level
In the absence of evidence of kidney damage, neither GFR category G1 nor G2 fulfill the criteria for CKD.

Kidney International Supplements (2013) **3**, 19–62

Table 6 | Albuminuria categories in CKD

Category	AER (mg/24 hours)	ACR (approximate equivalent) (mg/mmol)	ACR (approximate equivalent) (mg/g)	Terms
A1	<30	<3	<30	Normal to mildly increased
A2	30-300	3-30	30-300	Moderately increased*
A3	>300	>30	>300	Severely increased**

Abbreviations: AER, albumin excretion rate; ACR, albumin-to-creatinine ratio; CKD, chronic kidney disease.
*Relative to young adult level.
**Including nephrotic syndrome (albumin excretion usually >2200 mg/24 hours [ACR >2220 mg/g; >220 mg/mmol]).

Cardiovascular mortality

	ACR <10	ACR 10–29	ACR 30–299	ACR ≥300
eGFR ≥105	0.9	1.3	2.3	2.1
eGFR 90–105	Ref	1.5	1.7	3.7
eGFR 75–90	1.0	1.3	1.6	3.7
eGFR 60–75	1.1	1.4	2.0	4.1
eGFR 45–60	1.5	2.2	2.8	4.3
eGFR 30–45	2.2	2.7	3.4	5.2
eGFR 15–30	14	7.9	4.8	8.1

Chapter 4: Blood pressure management in CKD ND patients with diabetes mellitus

Kidney International Supplements (2012) **2,** 363–369; doi:10.1038/kisup.2012.54

4.1: We recommend that adults with diabetes and CKD ND with urine albumin excretion <30 mg per 24 hours (or equivalent*) whose office BP is consistently >140 mm Hg systolic or >90 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤140 mm Hg systolic and ≤90 mm Hg diastolic. *(1B)*

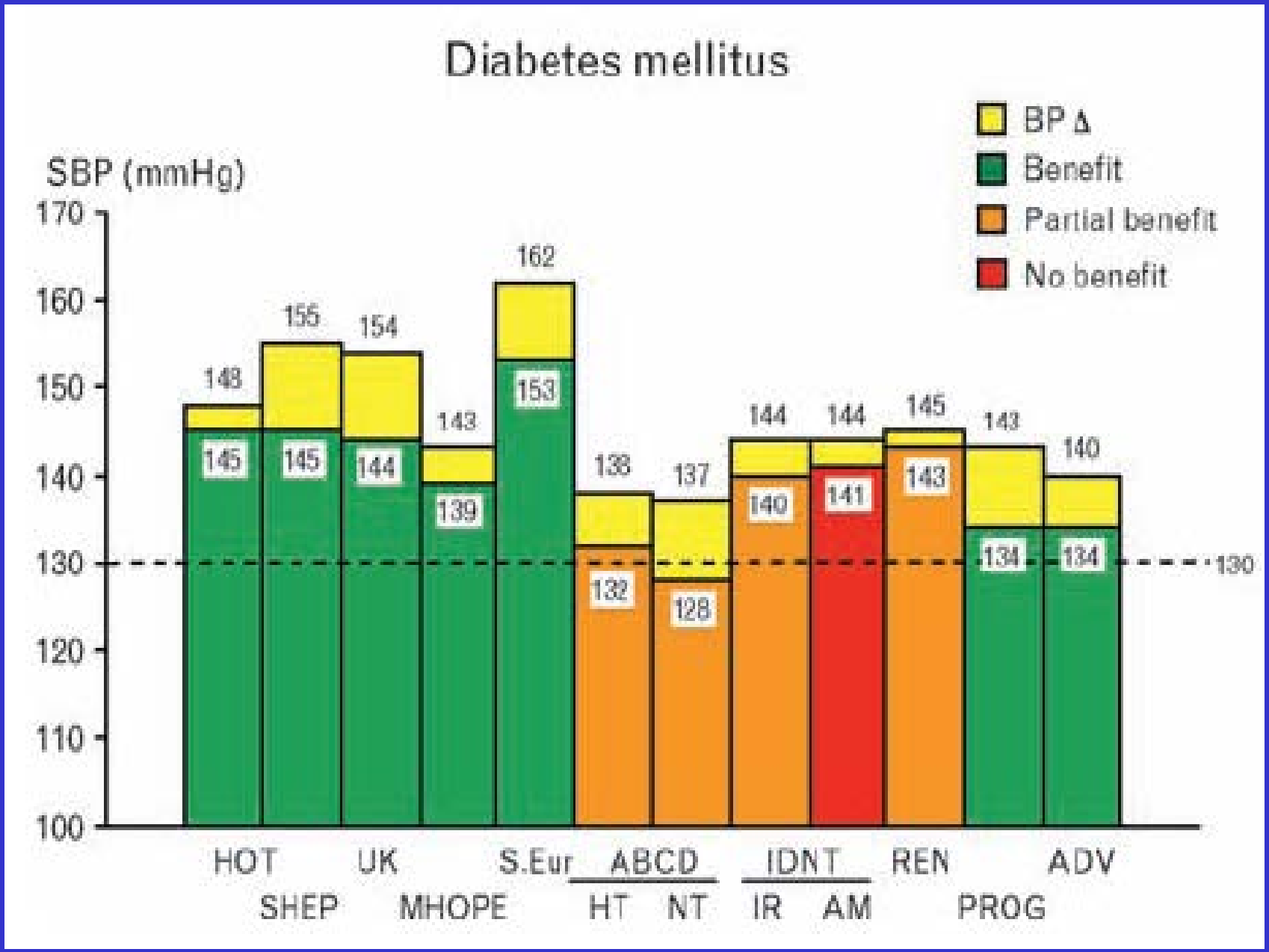
BP <140/90 mmHg

4.3: We suggest that an ARB or ACE-I be used in adults with diabetes and CKD ND with urine albumin excretion of 30 to 300 mg per 24 hours (or equivalent*). *(2D)*

4.2: We suggest that adults with diabetes and CKD ND with urine albumin excretion >30 mg per 24 hours (or equivalent*) whose office BP is consistently >130 mm Hg systolic or >80 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤130 mm Hg systolic and ≤80 mm Hg diastolic. *(2D)*

BP <130/80 mmHg

4.4: We recommend that an ARB or ACE-I be used in adults with diabetes and CKD ND with urine albumin excretion >300 mg per 24 hours (or equivalent*). *(1B)*


Diabetes mellitus
BP Δ
Benefit
Partial benefit
No benefit
SBP (mmHg)
170
160
150
140
130
120
110
100
148
155
154
143
162
138
137
144
144
145
143
140
145
145
144
139
153
132
128
140
141
143
134
134
130
HOT
SHEP
UK
MHOPE
S.Eur
ABCD
HT
NT
IDNT
IR
AM
REN
PROG
ADV

Effects of Intensive Blood-Pressure Control in Type 2 Diabetes Mellitus

The ACCORD Study Group*

ABSTRACT

BACKGROUND

There is no evidence from randomized trials to support a strategy of lowering systolic blood pressure below 135 to 140 mm Hg in persons with type 2 diabetes mellitus. We investigated whether therapy targeting normal systolic pressure (i.e., <120 mm Hg) reduces major cardiovascular events in participants with type 2 diabetes at high risk for cardiovascular events.

CONCLUSIONS

In patients with type 2 diabetes at high risk for cardiovascular events, targeting a systolic blood pressure of less than 120 mm Hg, as compared with less than 140 mm Hg, did not reduce the rate of a composite outcome of fatal and nonfatal major cardiovascular events. (ClinicalTrials.gov number, NCT00000620.)

This article (10.1056/NEJMoa1001286) was published on March 14, 2010, at NEJM.org.

N Engl J Med 2010.

Trials with different Meds but identical BP goals, diabetes + hypertension, CKD II-IV

STUDY	BP (mmHg)	outcome (n)	stats	
RENAAL	142/74 vs 140/74	CVdeath (113)	-10%	p=0.26
IDNT	144/80 vs 140/77	CVdeath (83)	-21%	p>0.2

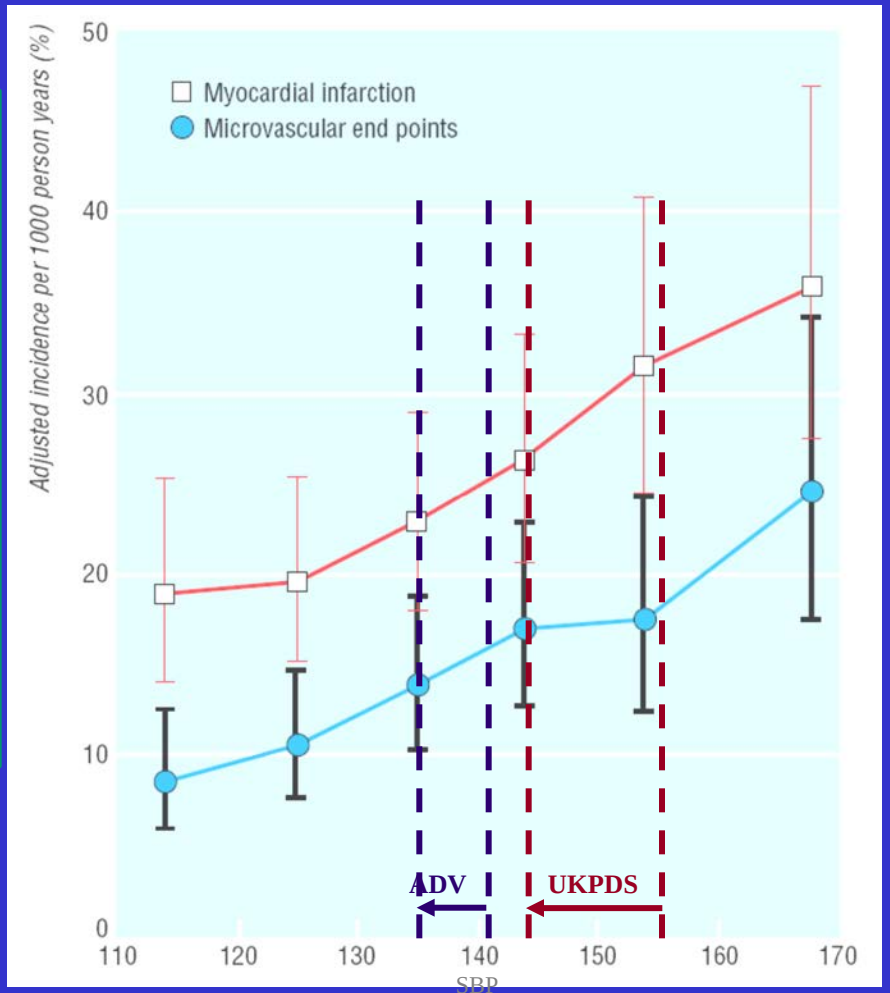
Trials with different Meds but identical BP goals, diabetes + hypertension, CKD II-IV

STUDY	BP (mmHg)	outcome (n)	stats
RENAAL	142/74 vs 140/74	CHF (216)	-32% p=0.005
IDNT	144/80 vs 140/77	CHF (193)	-28% p=0.048

ADVANCE BP reduction in context:

UK Prospective Diabetes Study

Achieved BP 134/75 mmHg



Decrease of the CV (15%) and renal events (20%)

The Lancet, Published online September 2, 2007 ADVANCE

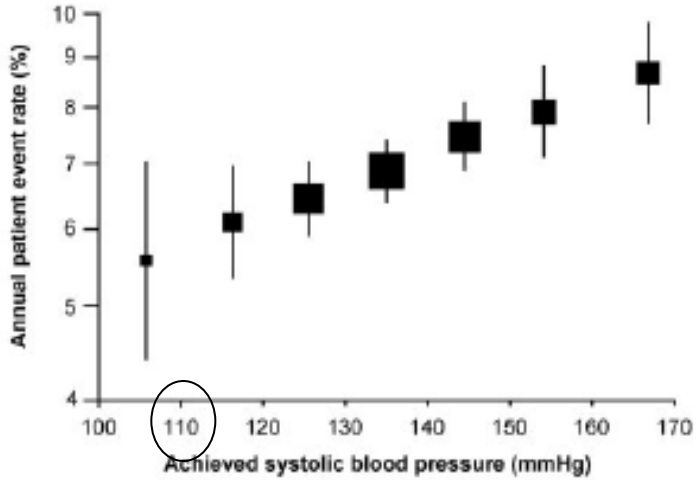
UKPDS BMJ 1998

Lowering Blood Pressure Reduces Renal Events in Type 2 Diabetes

Bastiaan E. de Galan,*† Vlado Perkovic,* Toshiharu Ninomiya,* Avinesh Pillai,* Anushka Patel,* Alan Cass,* Bruce Neal,* Neil Poulter,‡ Stephen Harrap,§ Carl-Erik Mogensen,‖ Mark Cooper,¶ Michel Marre,** Bryan Williams,†† Pavel Hamet,‡‡ Giuseppe Mancia,§§ Mark Woodward,* Paul Glasziou,‖‖ Diederick E. Grobbee,¶¶ Stephen MacMahon,* and John Chalmers,* on behalf of the ADVANCE Collaborative Group

JASN 2009

ADVANCE: renal protection until 110 mmHg



Median systolic blood pressure (mmHg)	106	116	125	135	144	154	168
No. of person-years	1431	4266	8974	11983	9138	4942	3470

Figure 4. Incidence of all renal events according to achieved BP levels, adjusted for age, gender, duration of diabetes, glycosylated hemoglobin, currently treated hypertension, history of macrovascular disease, electrocardiogram abnormalities (ventricular hypertrophy, Q waves, or atrial fibrillation), triglycerides, LDL cholesterol, HDL cholesterol, body mass index, current smoking,

CHAPTER 5: BLOOD PRESSURE MANAGEMENT IN KIDNEY TRANSPLANT RECIPIENTS

Am J Transpl 2009

CHAPTER 5: BLOOD PRESSURE MANAGEMENT IN KIDNEY TRANSPLANT RECIPIENTS

5.1: We suggest that in adults with CKD T whose office BP is consistently >130 mm Hg during systole or >80 mm Hg during diastole be treated to maintain a BP that is consistently ≤130/80 mm Hg, irrespective of level of urine albumin. *(2D)*

5.2: In adult CKD T patients, choose a BP-lowering agent after taking into account the time after transplantation, use of calcineurin inhibitors, and presence or absence of persistent proteinuria and other co-morbid conditions. *(Not Graded)*

Chapter 6: Blood pressure management in children with CKD ND

Kidney International Supplements (2012) **2,** 372–376; doi:10.1038/kisup.2012.56

6.1: We recommend that in children with CKD ND, BP-lowering treatment is started when BP is consistently above the 90th percentile for age, sex, and height. *(1C)*

6.2: We suggest that in children with CKD ND (particularly those with proteinuria), BP is lowered to consistently achieve systolic and diastolic readings less than or equal to the 50th percentile for age, sex, and height, unless achieving these targets is limited by signs or symptoms of hypotension. *(2D)*

P50

6.3: We suggest that an ARB or ACE-I be used in children with CKD ND in whom treatment with BP-lowering drugs is indicated, irrespective of the level of proteinuria. *(2D)*

Strict Blood-Pressure Control and Progression of Renal Failure in Children

The ESCAPE Trial Group*

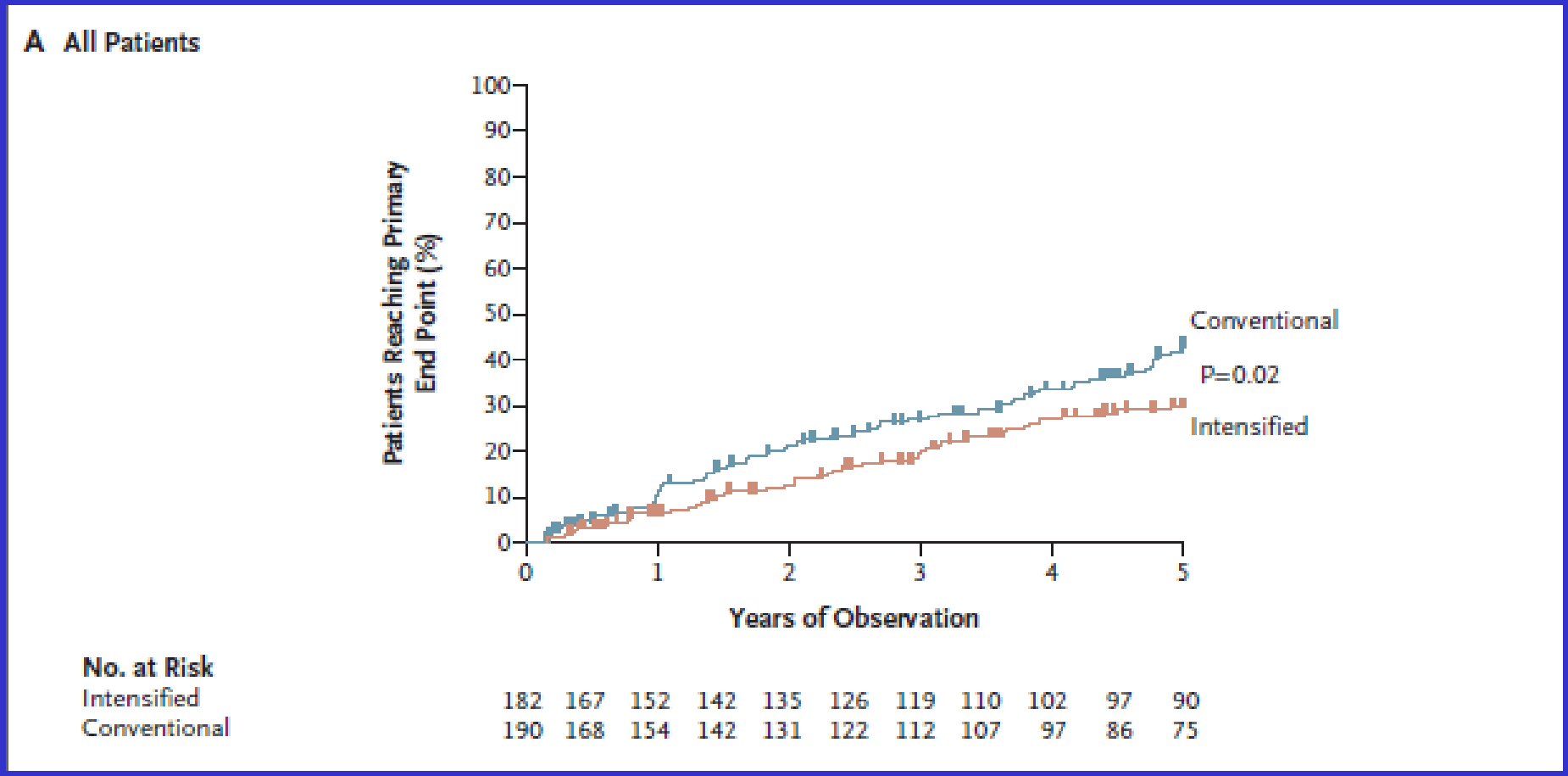


Figure 2. Progression of Renal Disease, According to Blood-Pressure–Control Group.

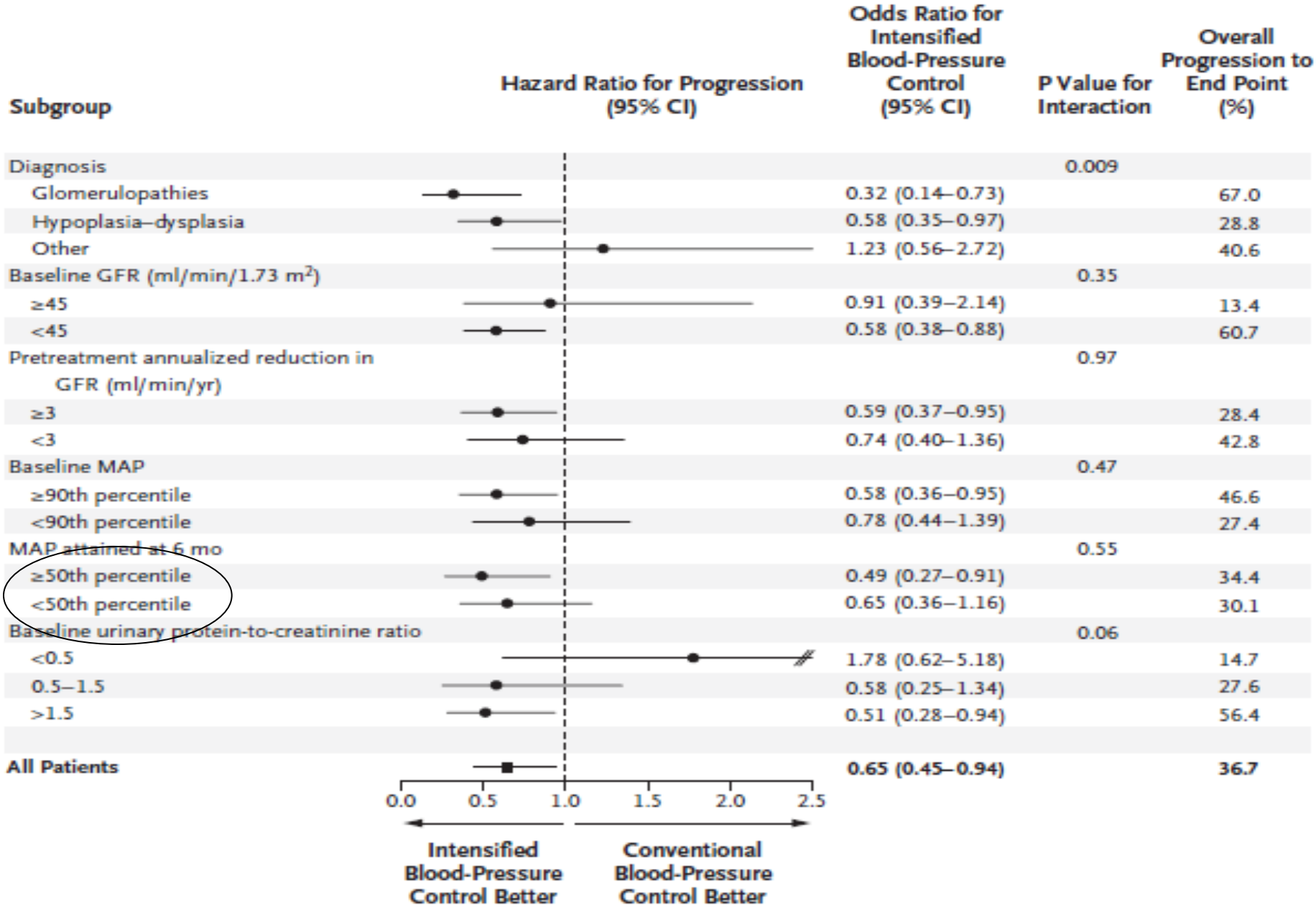


Figure 3. Forest Plot Showing the Results of Subgroup Analyses of the Primary End Point.

Chapter 7: Management of HTA in elderly CKD

- Problems of BP determination, GFR estimation, presence of comorbidities, vascular goals > renal outcomes
- Greater importance of SBP
- BP Target in uncomplicated patients <140/90 mmHg
- Benefit for stroke, CHF, not for death!

Chapter 7: BP management in elderly persons with CKD ND

Tailor treatment regimens in the elderly with CKD ND by carefully considering co-morbidities and their therapies, with gradual escalation of treatment and close attention to potential adverse events related to BP treatment, including electrolyte disorders, acute deterioration in kidney function, and orthostatic hypotension. ***(Not Graded)***

The effect of differing BP targets (e.g., 150/90 vs. 140/90) in elderly and very elderly patients with advanced CKD (CKD 3–4) should be assessed by prospective RCTs using a fixed-sequential BP-agent protocol (e.g., diuretic, ACE inhibitor or ARB, beta-blocker, and calcium-channel blocker) excluding only patients with angina or cardiomyopathy.

The effect of various sequences of combinations of agents should be similarly studied.

http://www.kidney-international.org review

Summary of KDIGO guideline. What do we really know about management of blood pressure in patients with chronic kidney disease?

David C. Wheeler[1] and Gavin J. Becker[2]

[1]Centre for Nephrology, University College London Medical School, London, UK and [2]Department of Nephrology, Royal Melbourne Hospital, Parkville, Victoria, Australia

Table 2 | Summary of recommendations for management of blood pressure in adult CKD patients with and without diabetes

Albuminuria (mg/day)[a]	BP Target mm Hg	Preferred agent
<30	≤140/90 mm Hg	None
30–300	≤130/80 mm Hg	ACE-I or ARB
>300	≤130/80 mm Hg	ACE-I or ARB

Abbreviations: ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BP, blood pressure; CKD, chronic kidney disease.

Conclusions 1

- A lower target may be chosen in CKD patients with proteinuria but after individualized risk-benefit assessment.
- The price to pay is a need for a higher number of antiHTA drugs and a risk of more frequent side-effects.

Brief discussion after these published guidelines

- What about the variability of BP measurement?
- What is the best method for accurate BP determination?
- Is there a real evidence-based lower limit for BP reduction in CKD ?
- What about proteinuria and its modification during treatment?

One point which is now well accepted: avoid dual RAS blockade (Ontarget, Altitude)

Blood pressure variability and outcomes in chronic kidney disease

Biagio Di Iorio[1], Andrea Pota[1], Maria Luisa Sirico[1], Serena Torraca[1], Lucia Di Micco[1], Roberto Rubino[2], Pasquale Guastaferro[3] and Antonio Bellasi[4]

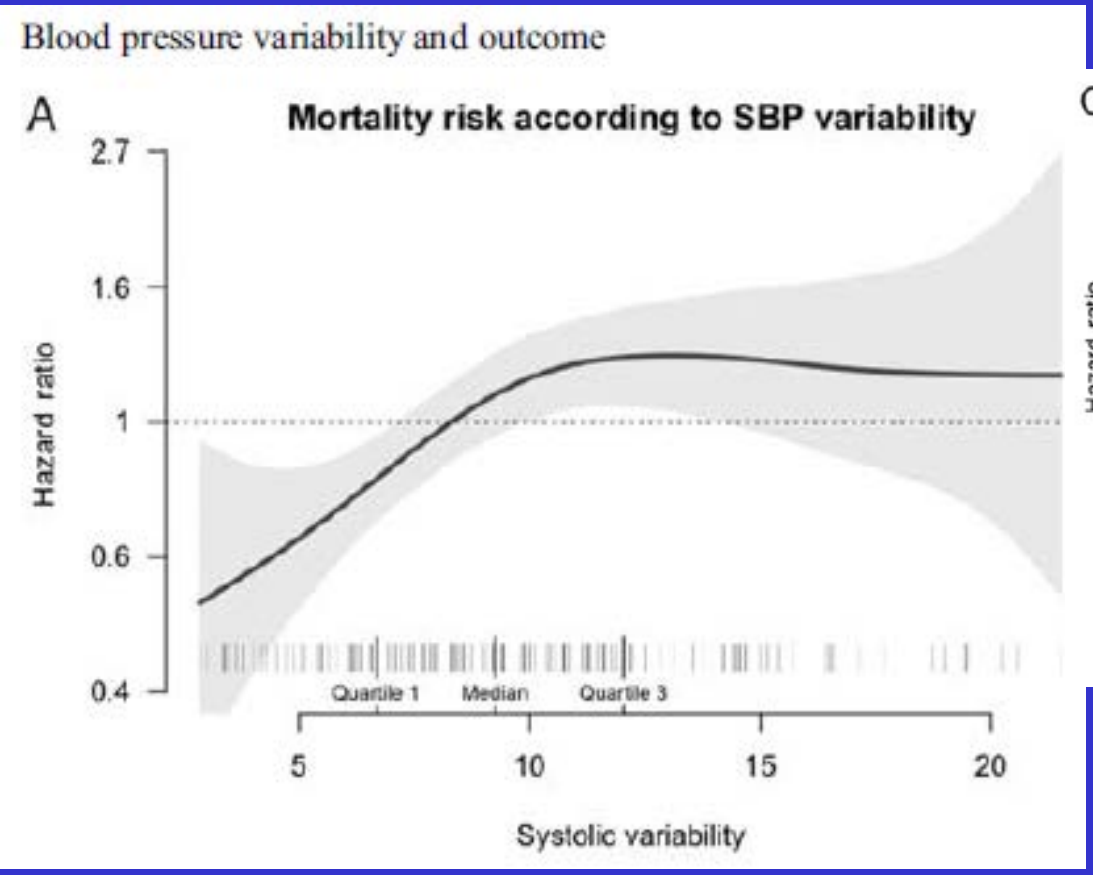
Nephrol Dial Transplant (2012) 0: 1–6

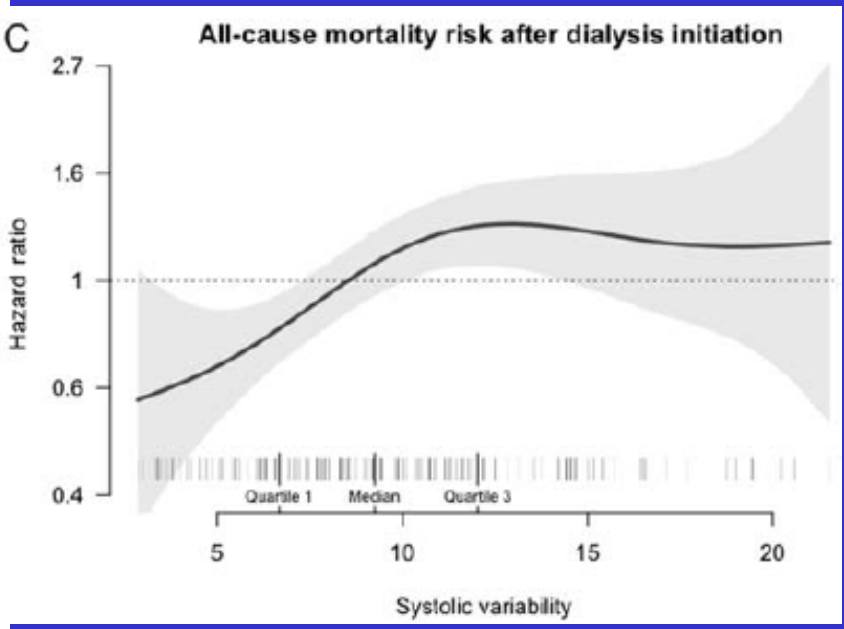
[1]Nephrology of Landolfi Hospital, Solofra AV, Italy, [2]Nephrology of Sant'Ottone Hospital, Ariano, AV, Italy, [3]Nephrology of Di Guglielmo Hospital, Sant'Angelo dei Lombardi, AV, Italy and [4]U.O.C. di Nefrologia, Dialisi, Ospedale Sant'Anna, Azienda Ospedaliera Sant'Anna, Como, Italy

Methods. We conducted a longitudinal retrospective, observational, multi-centre study in three tertiary care nephrology outpatient clinics. All the ambulatory CKD patients admitted to the outpatient clinics from 1 January 2004 to 31 December 2005 were screened for study eligibility. We selected all consecutive patients older than 18 years of age with a mean estimated glomerular filtration rate of <60 mL/min/m^2, free from cardiovascular disease. SBPV was defined as the ratio of the SD to the mean SBP of five values recorded during a run-in phase of 4–5 months. Data on dialysis inception and mortality were recorded through 31 December 2010.

Results. Overall, we selected a cohort of 374 elderly

Blood pressure variability and outcome





Nephrol Dial Transplant (2012) 0: 1–6

Some additional issues from the KDIGO 2012 guidelines on BP management in CKD

- What is the best method for accurate BP determination in CKD?

BP measurements in CKD (MDRD, AASK, REIN2)

Each of these three clinical trials targeted BP measured in the clinic. It is now becoming increasingly apparent that BP levels assessed in the clinic do not agree well with the usual level of BP; the usual level of BP is commonly assessed using 24-h ambulatory BP monitoring.[5] Using 24-h ambulatory BP monitoring as the reference standard, a recent meta-analysis revealed that ~20% of patients with CKD have white coat hypertension and about 5–10% have masked hypertension.[6]

What is the best method for measuring BP in CKD?

- ABPM!
- Home BP

Ambulatory BP Monitoring:

Recommended levels of normality for ambulatory BP

	BP levels (mm Hg)		
	Optimal	Normal	Abnormal
Daytime	<130/80	<135/85	>140/90
Nighttime	<115/75	<120/70	>125/75

Hypertension and Chronic Kidney Disease Progression: Why the Suboptimal Outcomes?

Anil K. Bidani, MD, FASN,[a] Karen A. Griffin, MD, FACP, FASN,[a] Murray Epstein, MD, FACP, FASN[b]

The American Journal of Medicine (2012) 125, 1057-1062

- Suboptimal management of BP is responsible for such evolution
- Improvement of patient education, chronotherapy and use of out-the-office BP mesurement to check the real BP control during the 24H.
- We need to develop strategies for achieving around-the-clock BP control

Prognostic Role of Ambulatory Blood Pressure Measurement in Patients With Nondialysis Chronic Kidney Disease

Roberto Minutolo, MD, PhD; Rajiv Agarwal, MD; Silvio Borrelli, MD; Paolo Chiodini, MSc; Vincenzo Bellizzi, MD, PhD; Felice Nappi, MD; Bruno Cianciaruso, MD; Pasquale Zamboli, MD; Giuseppe Conte, MD; Francis B. Gabbai, MD; Luca De Nicola, MD, PhD

Arch Intern Med. 2011;171(12):1090-1098

Conclusion: In chronic kidney disease, ambulatory BP measurement and, in particular, nighttime BP measurement, allows more accurate prediction of renal and cardiovascular risk; office measurement of BP does not predict any outcome.

Prognostic Role of Ambulatory Blood Pressure Measurement in Patients With Nondialysis Chronic Kidney Disease

Roberto Minutolo, MD, PhD; Rajiv Agarwal, MD; Silvio Borrelli, MD; Paolo Chiodini, MSc; Vincenzo Bellizzi, MD, PhD; Felice Nappi, MD; Bruno Cianciaruso, MD; Pasquale Zamboli, MD; Giuseppe Conte, MD; Francis B. Gabbai, MD; Luca De Nicola, MD, PhD

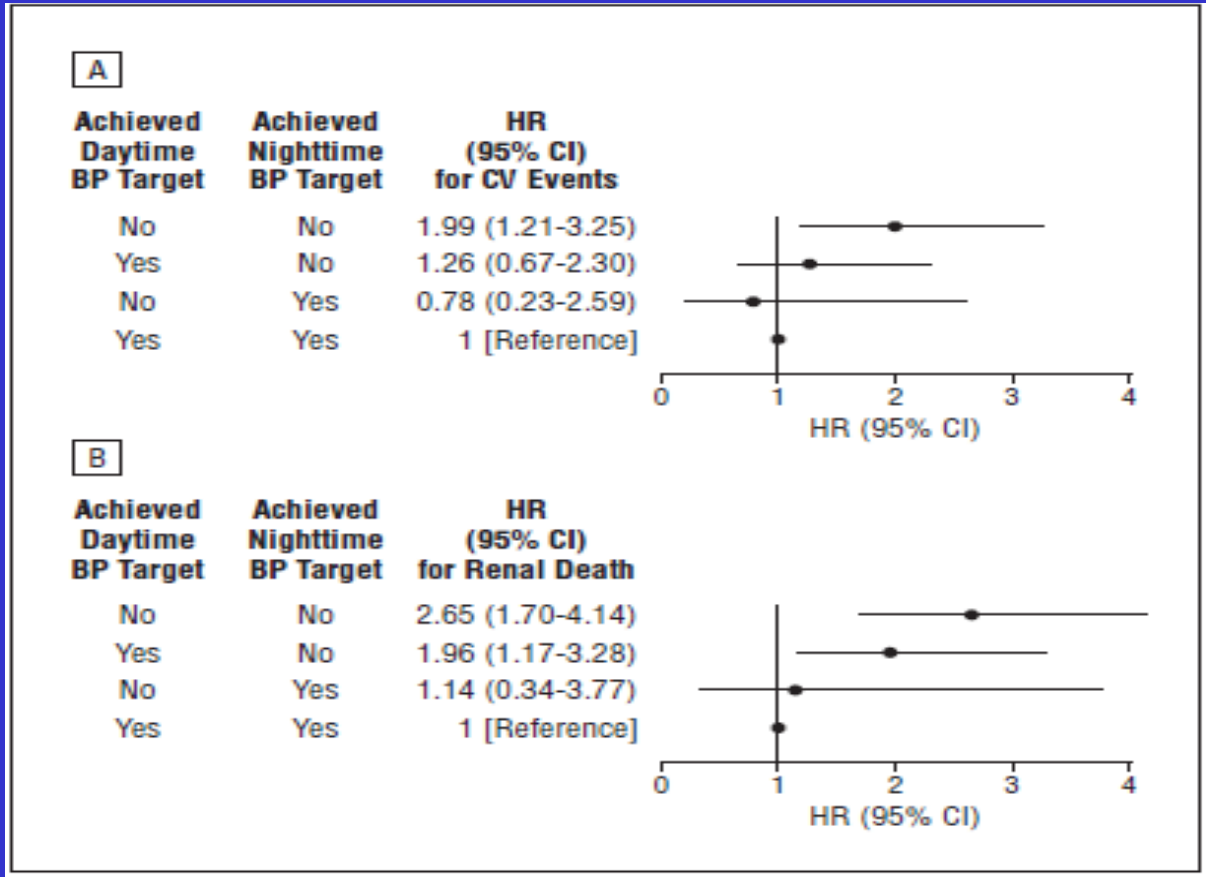


Figure 3. Risk of fatal and nonfatal cardiovascular (CV) events (A) and renal death (B) in patients stratified according to achievement of daytime blood pressure (BP) target (<135/85 mm Hg) and nighttime BP target (<120/70 mm Hg). CI indicates confidence interval; HR, hazard ratio.

Some additional issues from the KDIGO 2012 guidelines on BP management in CKD

- Is there an evidence-based lower limit for BP reduction ?

The NIH funded SPRINT trial currently recruiting patients in the US may clarify this issue. It will randomize over 7500 patients with systolic BP to targets of <140 mm Hg or <120 mm Hg, deliberately including approximately 1750 patients over 75, and followed for cardiovascular, cognitive and kidney end points over a period of 9 years, commencing 2010.[171,172]

Some additional issues from the KDIGO 2012 guidelines on BP management in CKD

- What is the importance of albuminuria in the management of CKD with high BP?

Importance of albuminuria on renal outcome

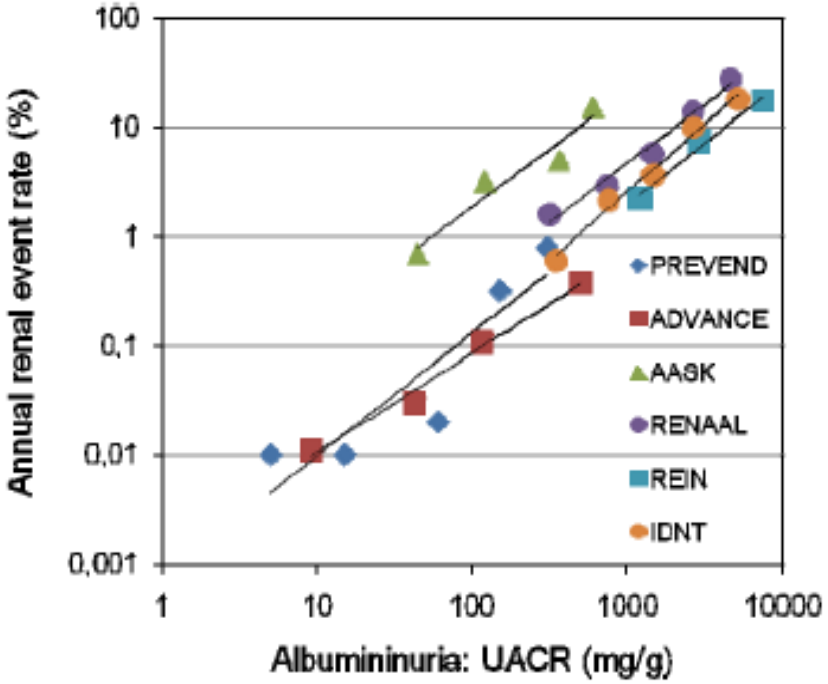


Figure 4: Level of urine albumin excretion predicts long term renal-function loss (kidney failure). The relation (slope) between the albuminuria level and outcome (kidney failure) is very similar for all different studied conditions. However, the level of risk varies per condition [25, 26, 28, 41].

Albuminuria as an independent target?

Importance of reducing albuminuria on renal outcome

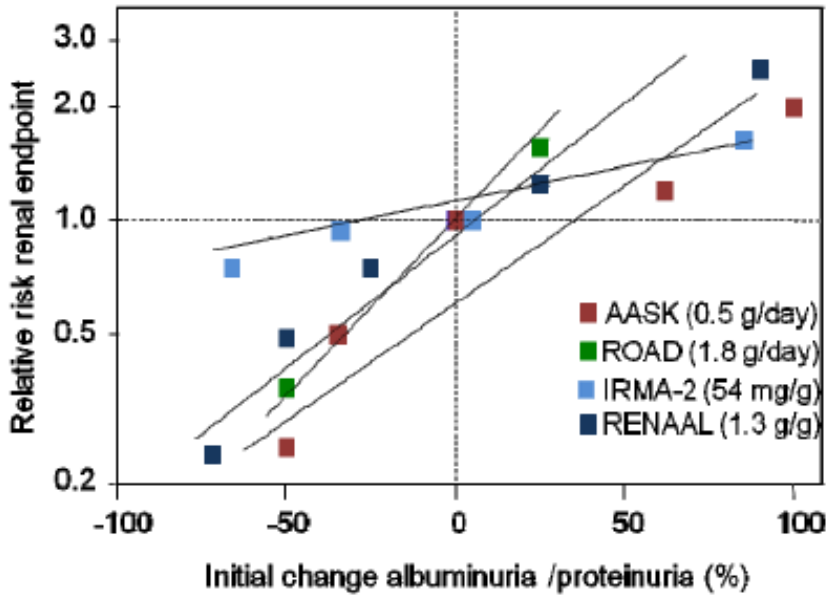


Figure 5: Short-term therapy-induced lowering of albuminuria is associated with long-term renal protection. Renal risk is expressed as annual rate of kidney failure (need for dialysis or transplantation) in all but the IRMA-2 study. In IRMA-2 the slope of the GFR was used as renal risk. The starting level of albuminuria for each study is indicated in the graph (next to the acronym of the study), showing that for all levels of albuminuria or proteinuria a clear relation between change and outcome is present [26, 28, 29, 43].

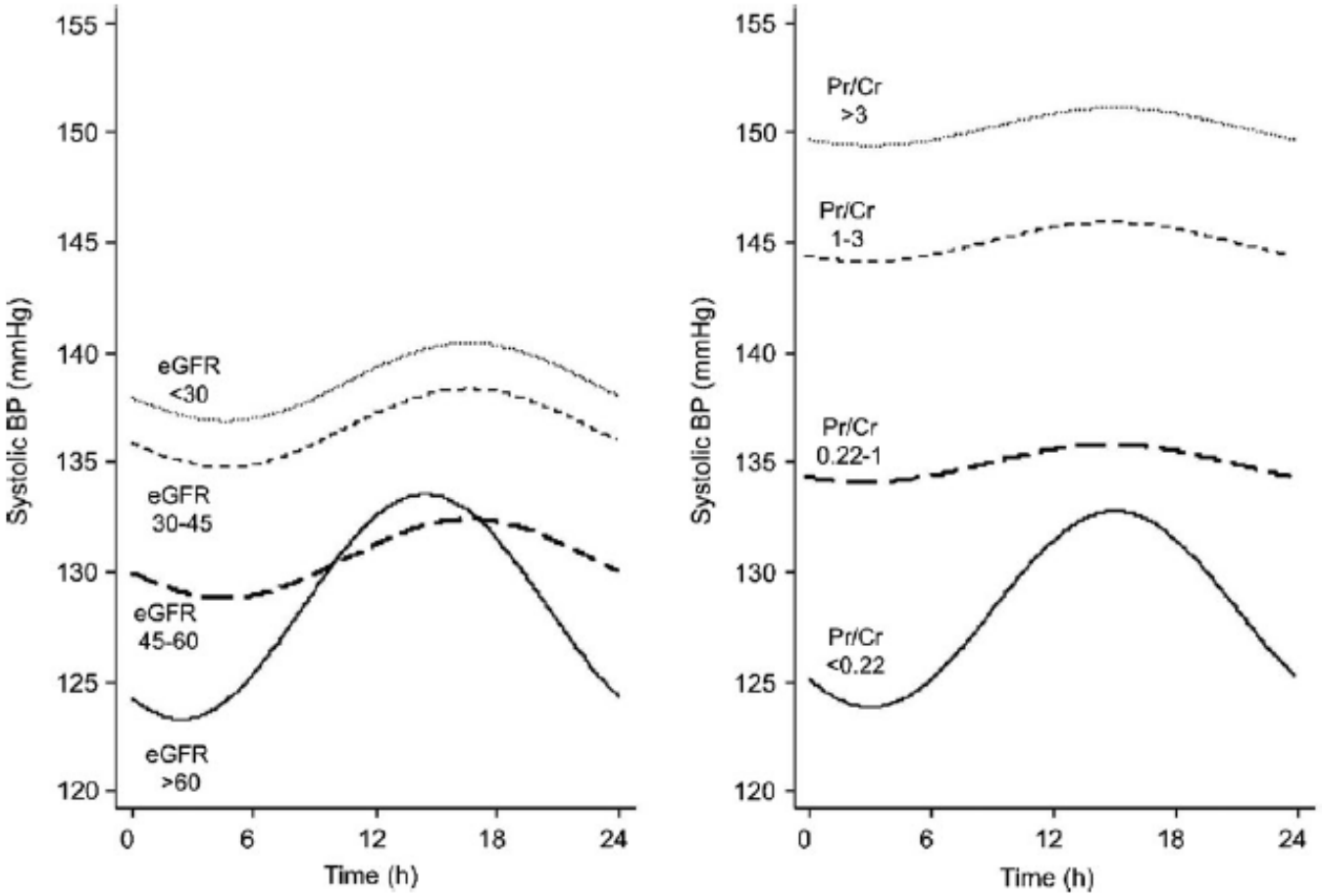
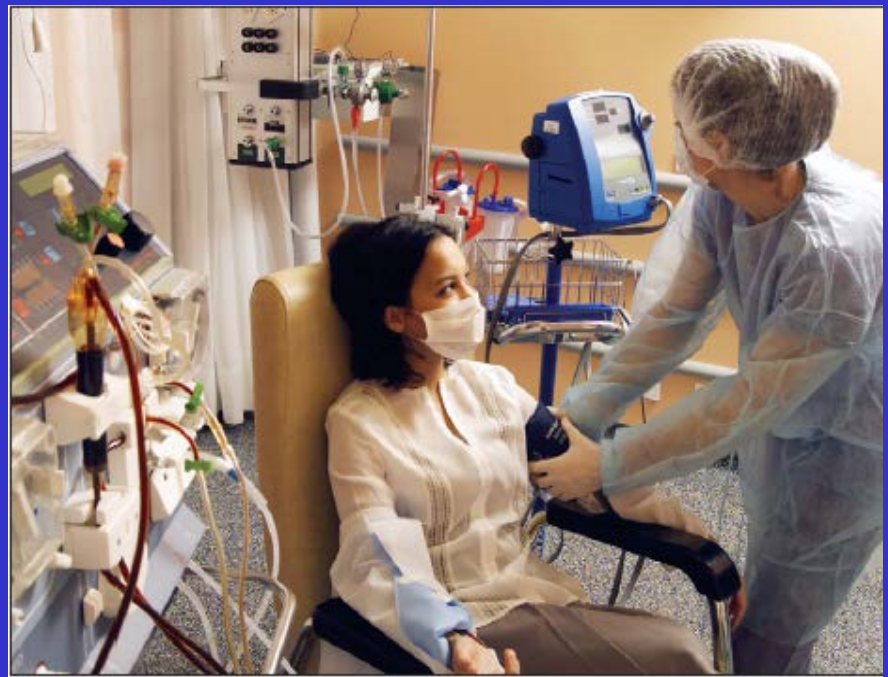


Fig. 4. Cosinor model of ambulatory systolic BP and its graded relationship with GFR and proteinuria. Increasing impairment in renal function was associated with an increasing level of systolic BP. The occurrence of proteinuria had a more profound effect on elevating systolic BP. Any impairment of GFR or occurrence of proteinuria blunted the circadian variation in systolic BP.

BP and Hemodialysis

- BP and the reverse epidemiology
- Several mechanisms for High BP in HD
- Quality of BP measurement
- Target of BP in HD?
- Optimal treatment?



Factors which may influence cardiovascular disease in dialysis and transplant patients—blood pressure (Chapter 10)

Janice Harper[1], Alex Hodsman[2], Julie Gilg[2], David Ansell[2] and Andrew J. Williams[3]

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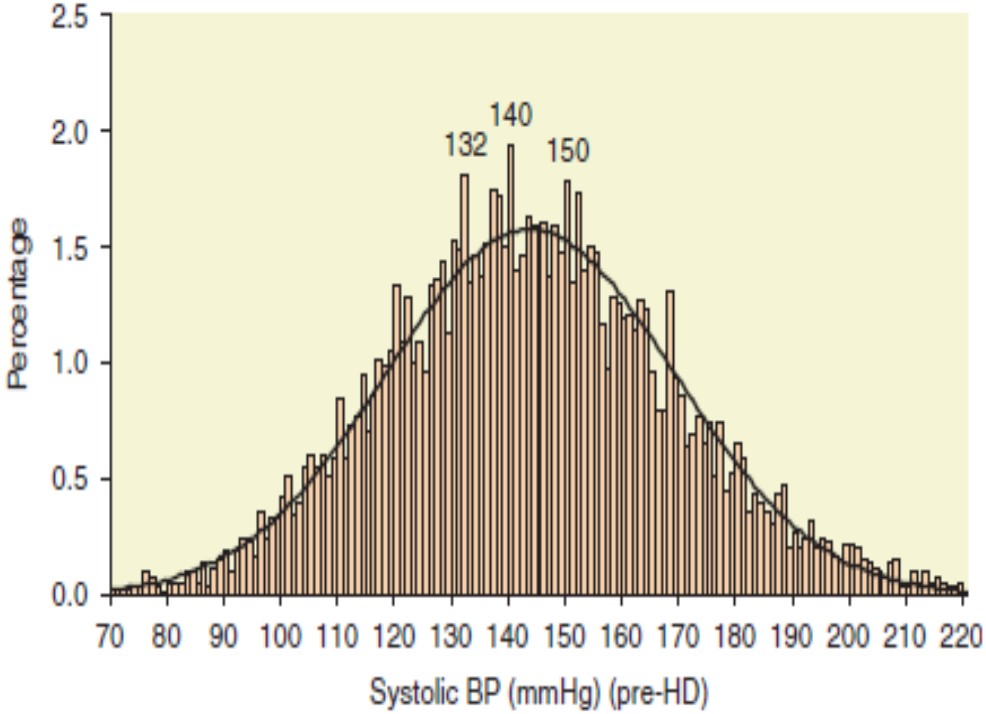
Pre-haemodialysis blood pressure <140/90 mmHg. Post-haemodialysis, peritoneal dialysis and renal transplant blood pressure <130/80 mmHg.

43% preHD <140/90 mmHg
48% postHD <130/80 mmHg



Blood pressure levels and mortality risk among hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study

Kidney International (2012) **82,** 570–580;

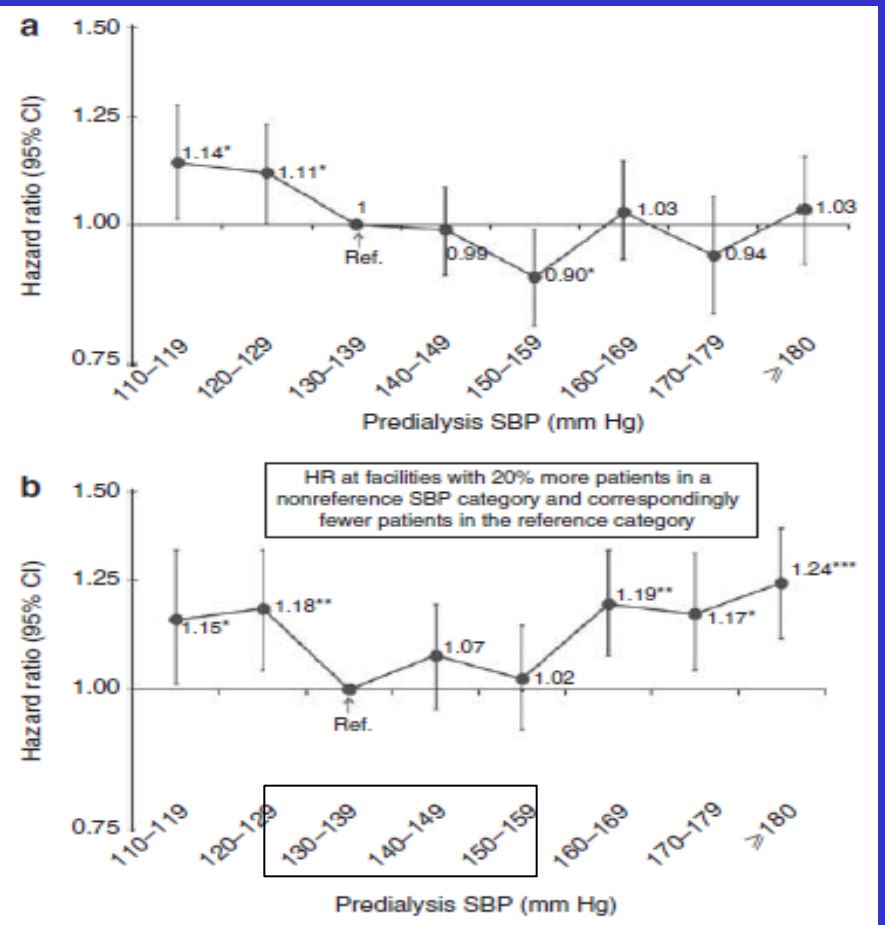


Figure 3 | Predialysis systolic blood pressure (SBP) and mortality (fully adjusted model). (**a**) Mortality by patient-level predialysis SBP categories (fully adjusted). (**b**) Mortality by facility-level predialysis SBP categories (fully adjusted). A total of 24,525 hemodialysis patients from 920 facilities in Dialysis Outcomes and Practice Patterns Study (DOPPS) I–III with end-stage renal disease duration of >180 days, excluding patients with predialysis SBP <110 mm Hg. Cox models were stratified by geographic region

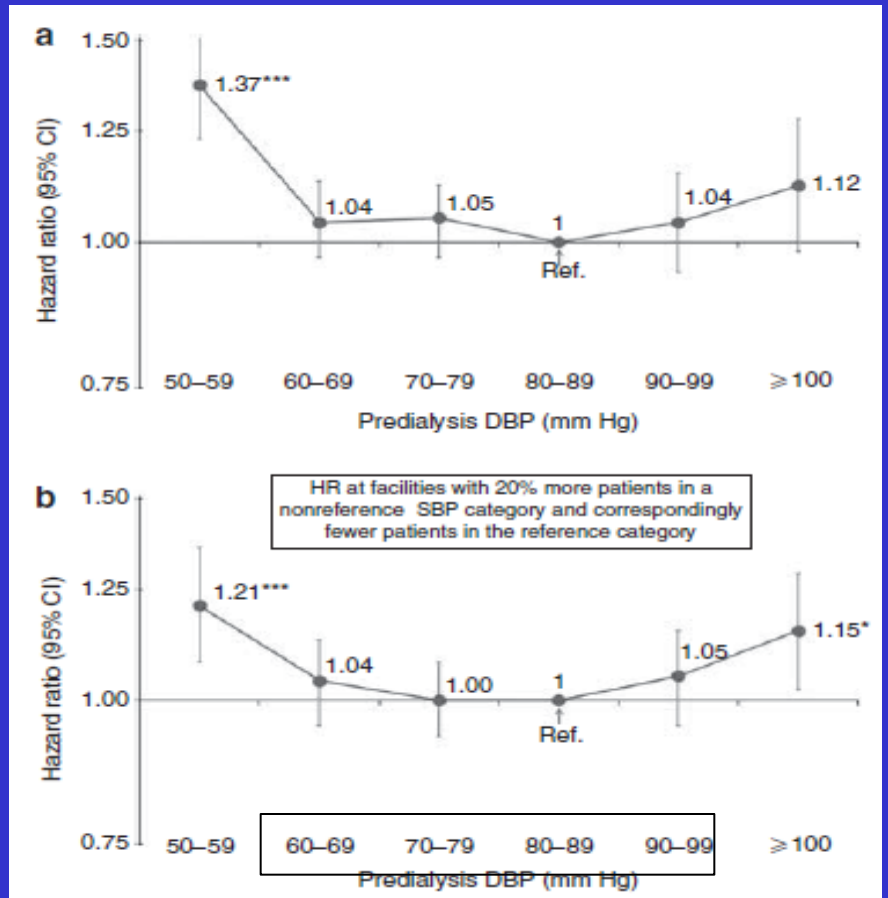


Figure 4 | Predialysis diastolic blood pressure (DBP) and mortality (fully adjusted model). (**a**) Mortality by patient-level predialysis DBP categories (fully adjusted). (**b**) Mortality by facility-level predialysis DBP categories (fully adjusted). A total of 25,424 hemodialysis patients from 919 facilities in Dialysis Outcomes and Practice Patterns Study (DOPPS) I–III with end-stage renal disease duration of >180 days, excluding patients with predialysis DBP <50 mm Hg. Cox models are as described for Figure 3.

Blood pressure levels and mortality risk among hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study

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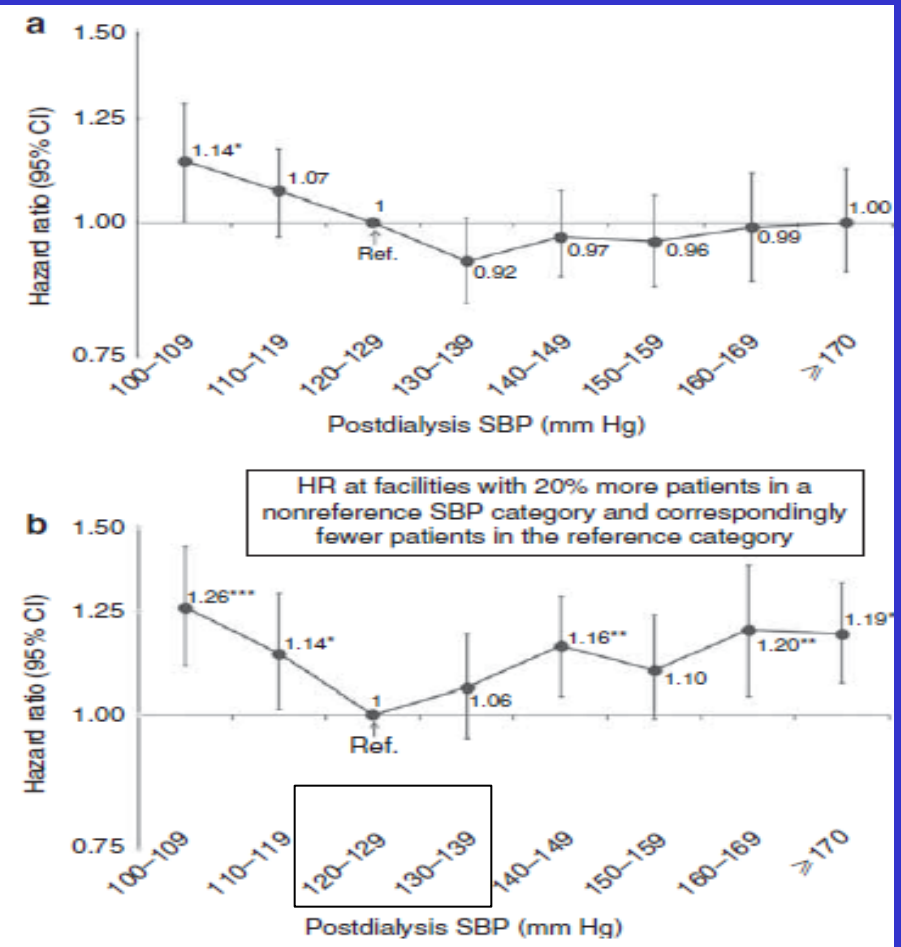


Figure 7 | Postdialysis systolic blood pressure (SBP) and mortality (fully adjusted model). (**a**) Mortality by patient-level postdialysis SBP categories (fully adjusted). (**b**) Mortality by facility-level postdialysis SBP categories (fully adjusted). A total of 24,303 hemodialysis patients from 915 facilities in Dialysis Outcomes and Practice Patterns Study (DOPPS) I–III with end-stage renal disease duration of >180 days, excluding patients with postdialysis SBP <100 mm Hg. Cox models are as described

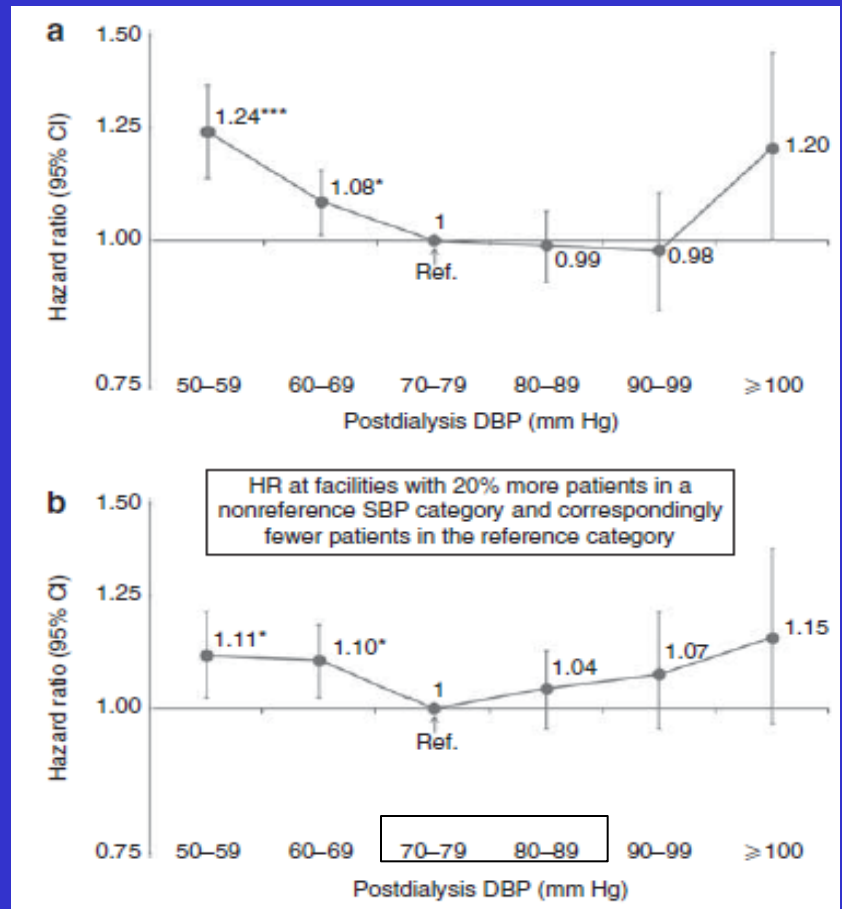


Figure 8 | Postdialysis diastolic blood pressure (DBP) and mortality (fully adjusted model). (**a**) Mortality by patient-level postdialysis DBP categories (fully adjusted). (**b**) Mortality by facility-level postdialysis DBP categories (fully adjusted). A total of 24,805 hemodialysis patients from 911 facilities in Dialysis Outcomes and Practice Patterns Study (DOPPS) I–III with end-stage renal disease duration of >180 days, excluding patients with postdialysis DBP <50 mm Hg. Cox models are as described

PreHD systolic BP overestimates ABP

Study	n	PreHD SBP - Syst ABP (mm Hg)	SDD	r	Weighted Mean Difference in BP (mm Hg) (95% CI)	Weight (%)
van de Borne, 1992	13	17	20.9	0.69		1.2%
Elisaf, 1996	12	1	13.9	0.69		2.5%
Huisman, 1995	12	14.3	13.4	**0.76**		2.7%
Conlon, 2000	31	3.8	20.3	0.69		3.0%
Berns, 1999	28	1.1	18.7	0.69		3.2%
Peixoto, 2000	21	2	15.2	0.69		3.7%
Kooman, 1992	22	13	14.7	**0.94**		4.1%
Erturk, 1996	40	-3.9	19.6	0.69		4.2%
Nishikimi, 2001	35	21.8	17.3	0.69		4.7%
Cheigh, 1992	53	5.3	20.3	0.69		5.2%
Savage, 1997	27	6.7	14.5	0.69		5.2%
Mitra, 1999	40	17	16.9	0.69		5.7%
Conlon, 1996	35	10.5	15.4	**0.67**		6.0%
Santos, 2003	71	15	20.4	0.69		6.9%
Canella, 2000	55	16	17.2	**0.51**		7.5%
Zoccali, 1999	64	5.4	17.5	0.69		8.5%
Agarwal, 2001	67	13.5	17.1	**0.70**		9.3%
Fagugli, 2002	66	-0.9	12.8	0.69		16.3%
Summary	**692**	**8.3**	**16.7**	**Q=129.8, p<0.001**		**100.0%**

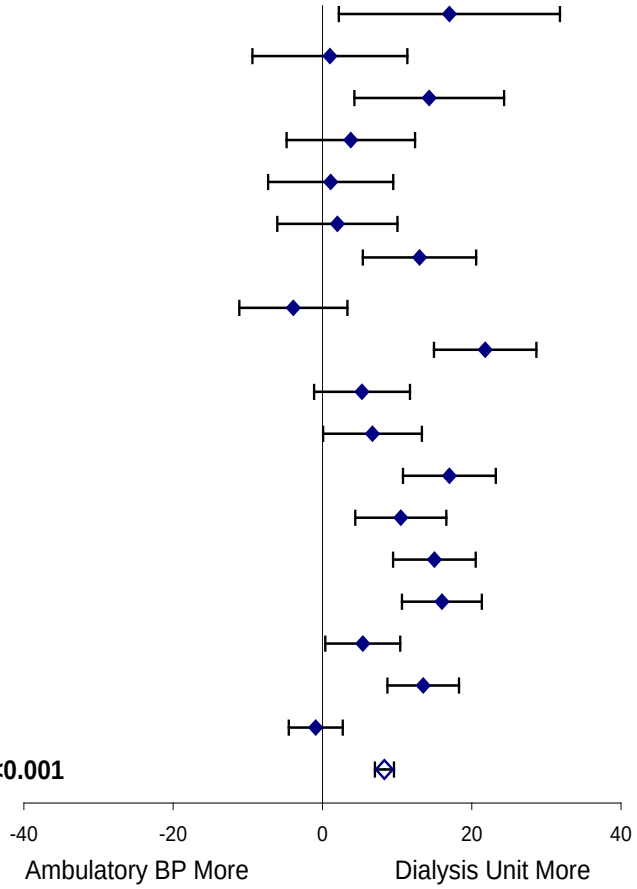


Figure 1

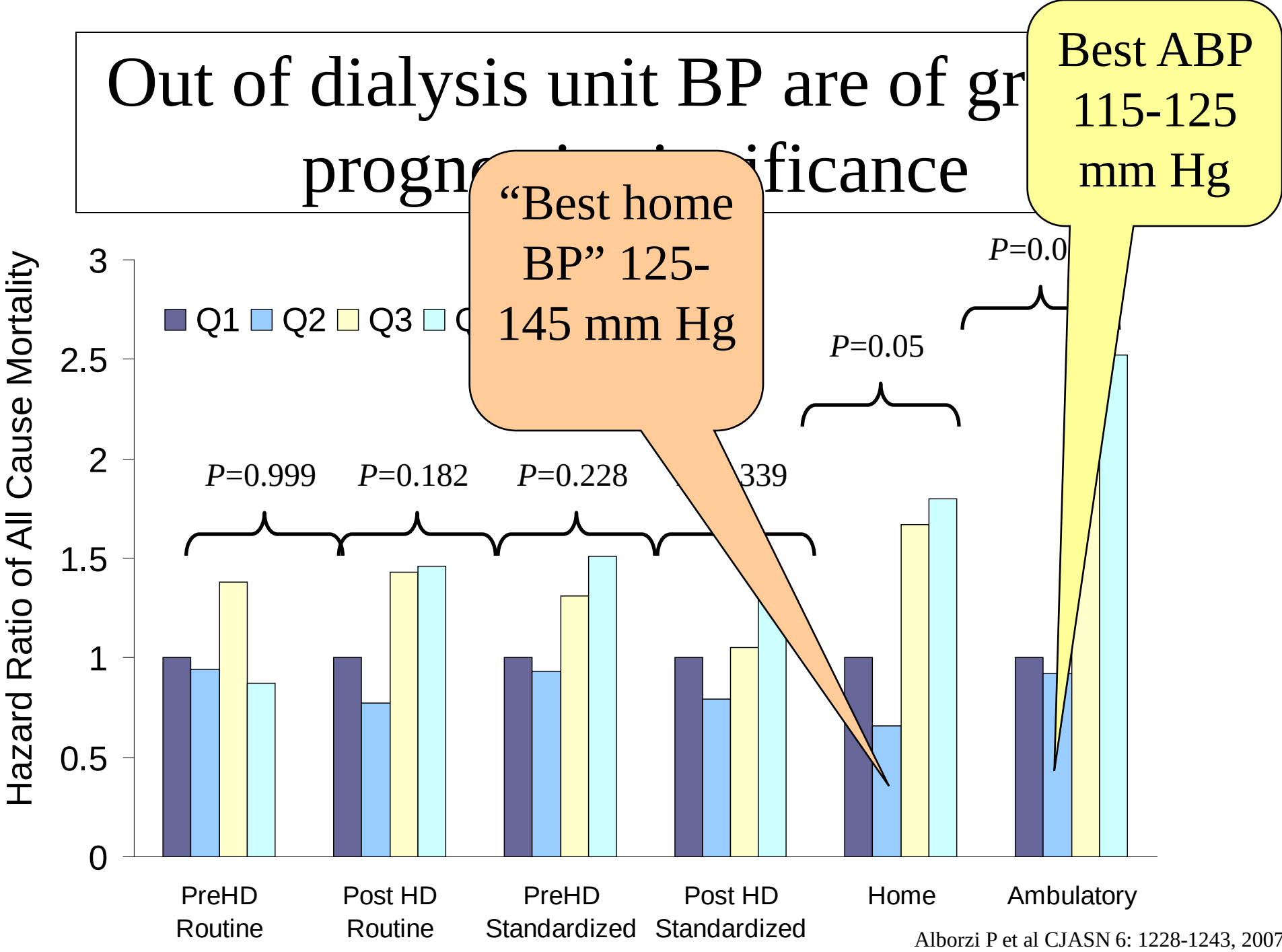
Agarwal R, et al. CJASN 1: 389-398, 2006

Is out of dialysis unit BP of prognostic value?

- Baseline cohort followed for 2 years for all-cause mortality.
- 46 patients (31%) died.
- Quartiles of systolic BP associated with mortality in a Cox model.

Alborzi P et al CJASN 6: 1228-1243, 2007

Out of dialysis unit BP are of gr
progn ificance



Alborzi P et al CJASN 6: 1228-1243, 2007

Hypertension control may benefit dialysis patients

- Home BP monitoring should be more routinely used for the diagnosis and management of hypertension in hemodialysis patients.
- Epidemiological data suggest that lower BP (<130 mmHg) may be linked to mortality and higher BP may not hurt.
- Randomized trials suggest that lowering BP does not hurt, and may in fact help.
- Adequately powered, RCTs are urgently needed to ascertain to what level should the BP be lowered to realize cardiovascular benefits in dialysis patients.

Conclusions 2

- Confirmation of a high BP level is necessary through out-of-the clinic BP measurement
- In CKD, ABPM offers night-time BP information useful for CV and renal risk evaluation.
- BP variability is a new point to be considered in the future.
- Proteinuria but also other specific risk factors (Phosphate, anemia, inflammation,..) should be integrated in the management of hypertension in CKD