CKD-MBD in Korea

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CKD-MBD in Korea

- Observational Study from
  - Registry
  - Cohort
  - Cross sectional Study

- Clinical trials
- Basic research

- CKD-MBD National Guideline in Korea

Registry

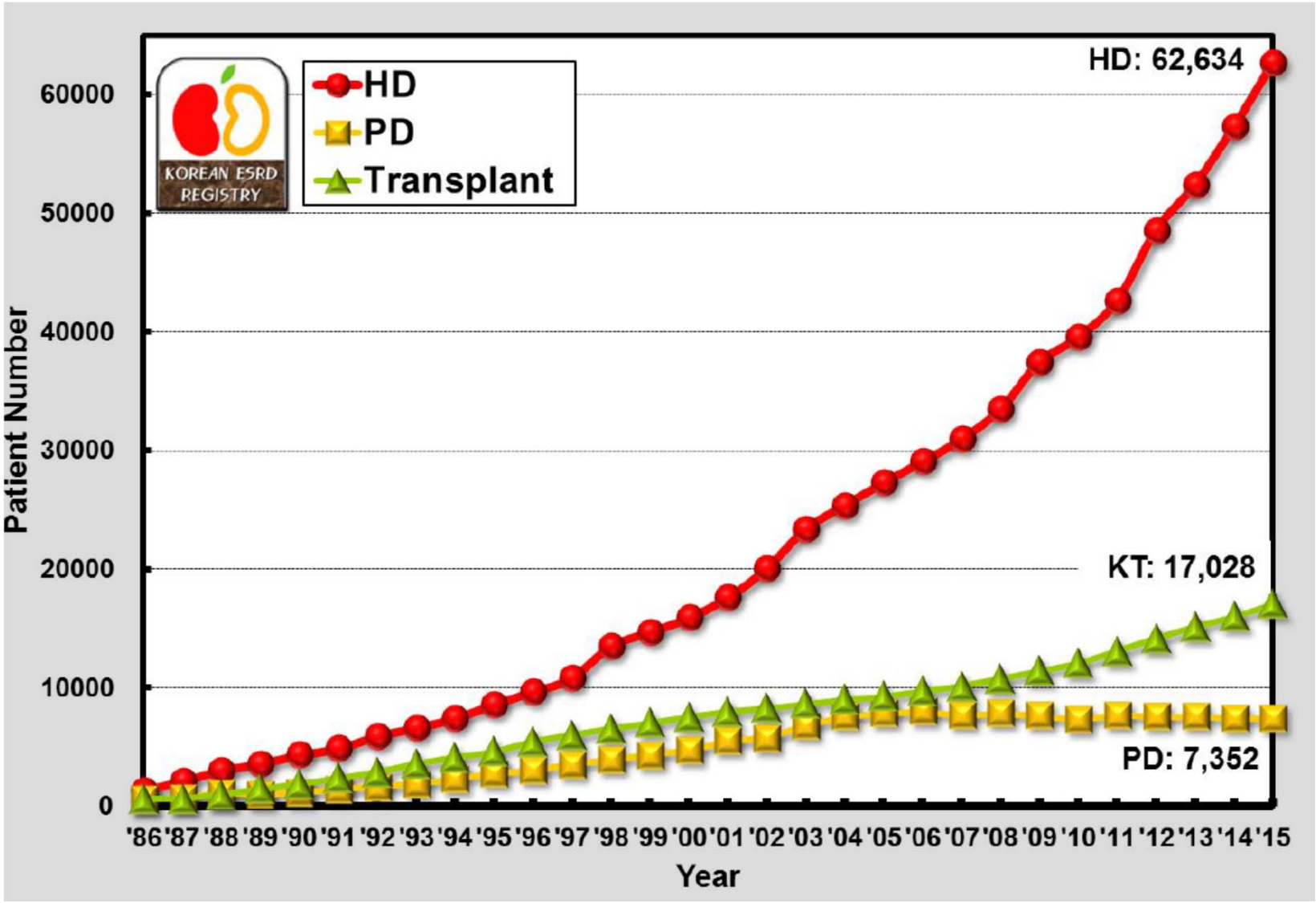
Registry

- Korean Society of Nephrology Registry for patients on RRT since 1986
  - CKD-MBD since 2012

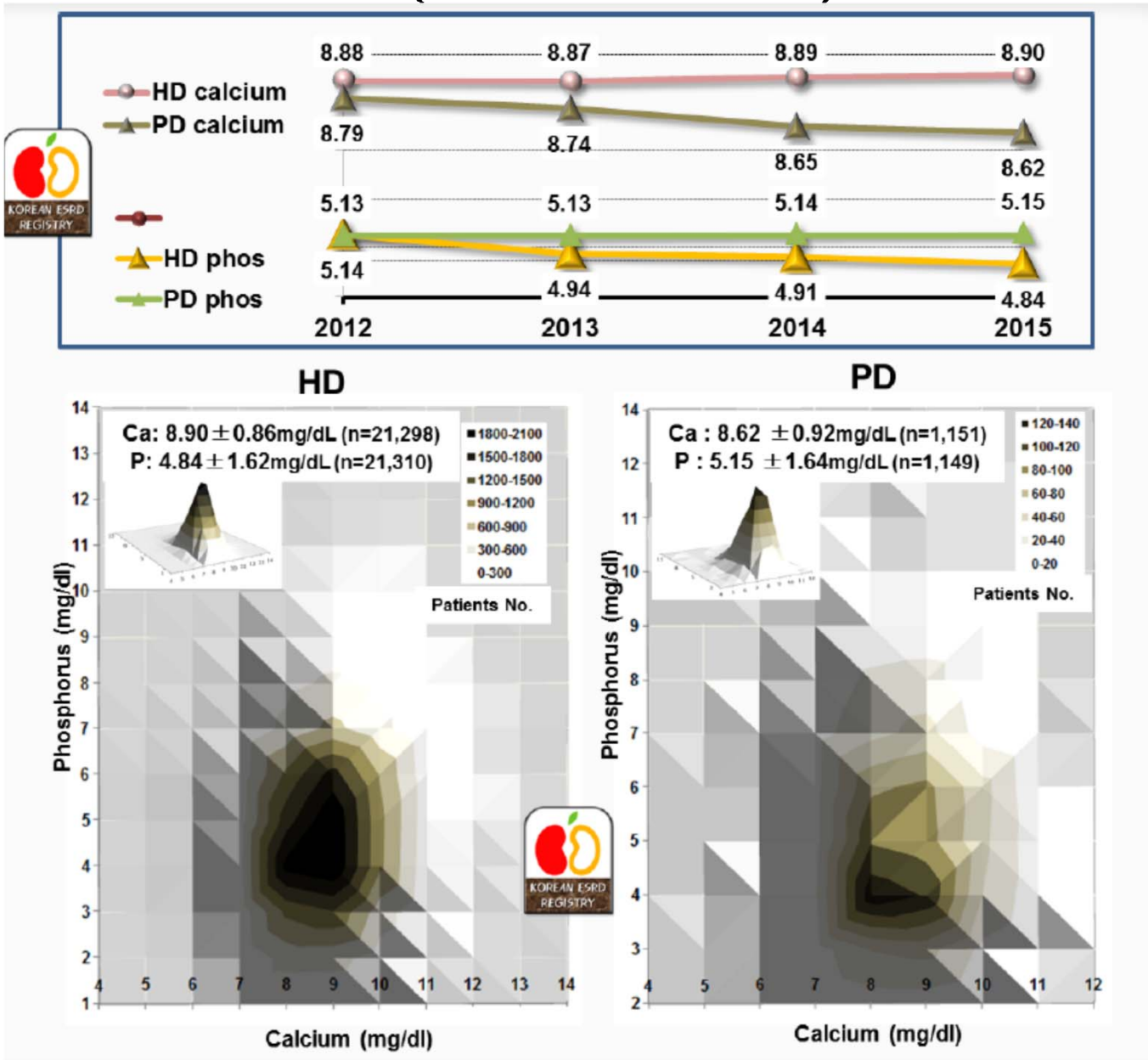
- Korea National Health and Nutrition Examination Survey (KNHANES) databases since 1998

  - 1998~2005
  - 10,000 persons in total in all 192 PSUs per year annual survey program by Korea Centers for Disease Control and Prevention (KCDC) since 2007
  - in the mobile examination centers since 2008
  - the computer-assisted personal interview system since 2013

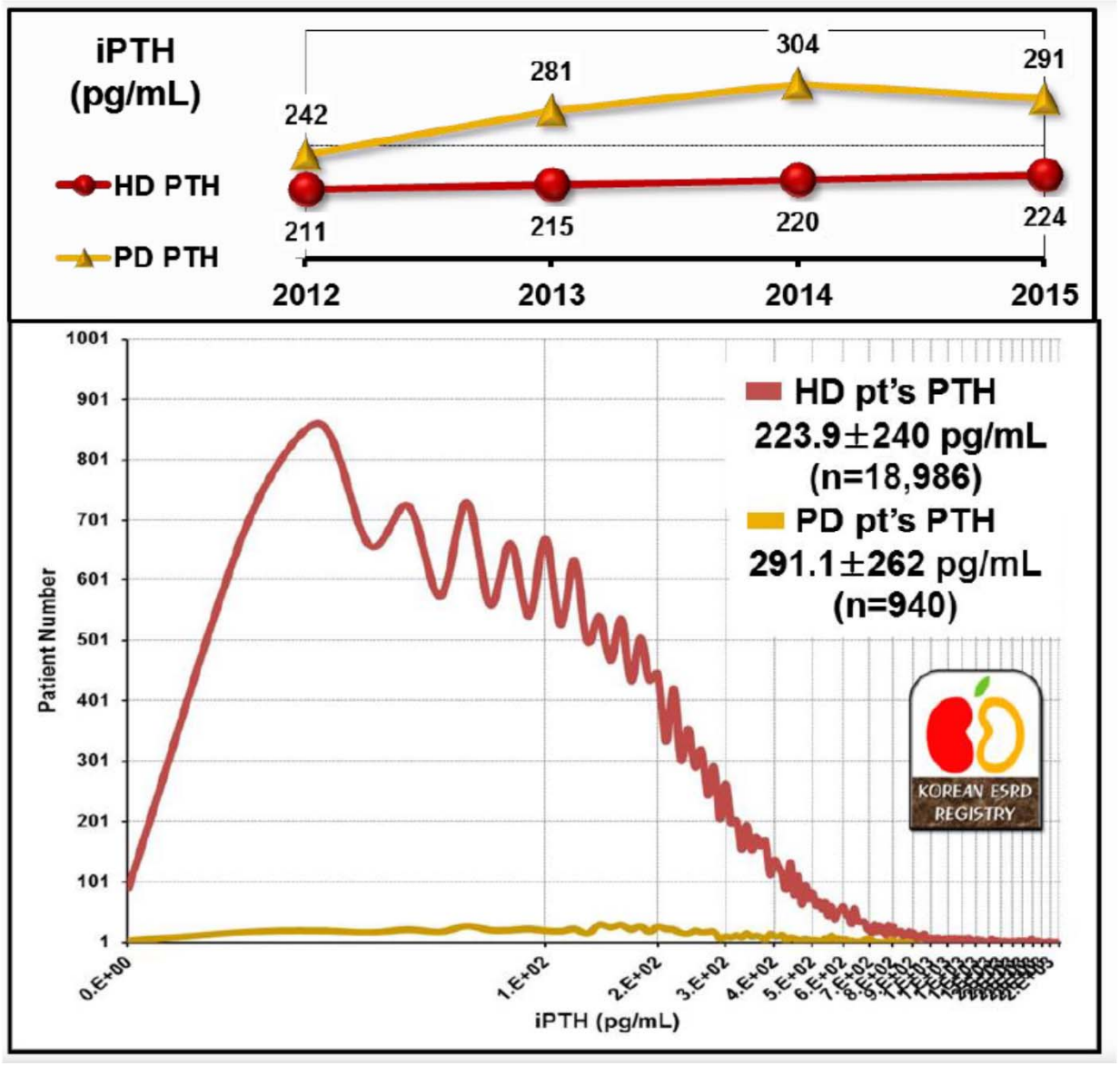
Patient Number on RRT from KSN

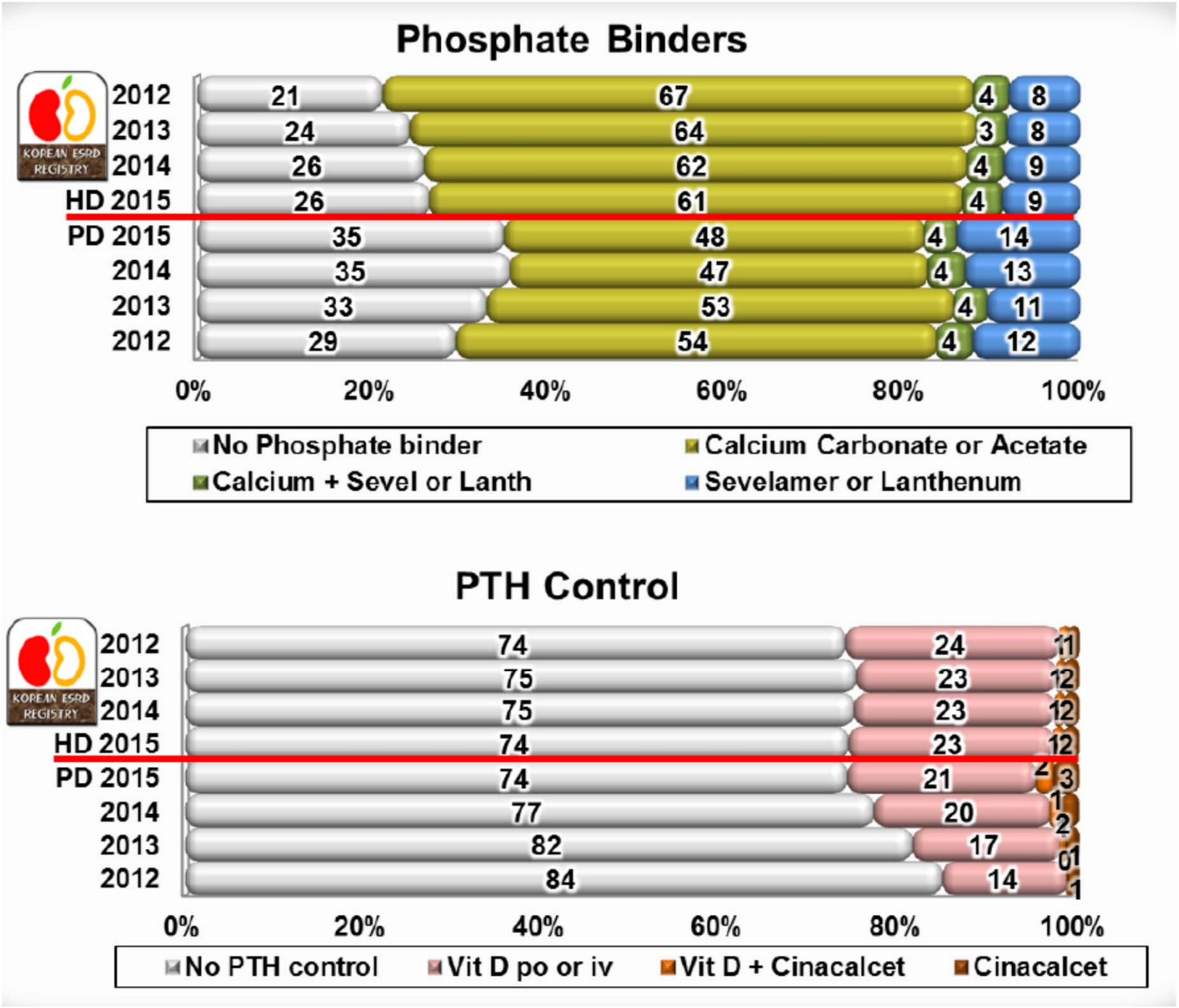


Calcium & P (2012~2015) from KSN



PTH (2012~2015) from KSN




Phosphate Binders
KOREAN ESRD REGISTRY
2012 21 67 4 8
2013 24 64 3 8
2014 26 62 4 9
HD 2015 26 61 4 9
PD 2015 35 48 4 14
2014 35 47 4 13
2013 33 53 4 11
2012 29 54 4 12
0% 20% 40% 60% 80% 100%
No Phosphate binder
Calcium Carbonate or Acetate
Calcium + Sevel or Lanth
Sevelamer or Lanthenum
PTH Control
KOREAN ESRD REGISTRY
2012 74 24 1 1
2013 75 23 1 2
2014 75 23 1 2
HD 2015 74 23 1 2
PD 2015 74 21 2 3
2014 77 20 1 2
2013 82 17 0 1
2012 84 14 1 1
0% 20% 40% 60% 80% 100%
No PTH control
Vit D po or iv
Vit D + Cinacalcet
Cinacalcet

Associations between Renal Hyperfiltration and Serum Alkaline Phosphatase

Oh SW, Han SY et al. Plos one 2015

- A retrospective observational study of the 21,308 adults in the Korea National Health and Nutrition Examination Survey IV-V databases (2008–2011) (KNHANES) was performed.
- Renal hyperfiltration was defined as exceeding the age- and sex-specific 97.5th percentile. We divided participants into 4 groups according to their estimated glomerular filtration rate (eGFR): >120, 90–119, 60–89, and <60 mL/min/1.73 m^2.
- The participants with eGFR >120 mL/min/1.73 m^2 showed the highest risk for MS, in the highest ALP quartiles (3.848, 95% CI, 1.876–7.892), compared to the lowest quartile.
- Similarly, the highest risk for DM, in the highest ALP quartiles, was observed in participants with eGFR >120 ml/min/1.73 m^2 (2.166, 95% CI, 1.084–4.329).
- ALP quartiles were significantly associated with albuminuria in participants with eGFR ≥ 60 ml/min/1.73m^2.
- The highest ALP quartile had a 1.631-fold risk elevation for albuminuria with adjustment of age and sex. (95% CI, 1.158-2.297, P = 0.005).
- After adjustment, the highest ALP quartile had a 1.624-fold risk elevation, for renal hyperfiltration (95% CI, 1.204–2.192, P = 0.002).

Table 2. Associations between serum alkaline phosphatase quartiles and metabolic syndrome according to the estimated glomerular filtration rate (eGFR).

	ALP quartiles* <176 (IU/L)	OR (95% CI) 176–214 (IU/L)	215–261 (IU/L)	>262 (IU/L)
eGFR(ml/min/1.73m^2)				
>120	reference	1.979	3.357	3.848
		(0.931–4.204)	(1.615–6.979)	(1.876–7.892)
90–119	reference	1.244	1.583	1.899
		(0.974–1.589)	(1.254–2.000)	(1.504–2.399)
60–89	reference	1.327	1.525	1.637
		(1.029–1.712)	(1.192–1.951)	(1.283–2.087)
<60	reference	1.625	1.020	1.450
		(0.727–3.630)	(0.462–2.251)	(0.697–3.013)

Table 3. Associations between serum alkaline phosphatase quartiles and diabetes according to the estimated glomerular filtration rate (eGFR).

	ALP quartiles* <176 (IU/L)	OR (95% CI) 176–214 (IU/L)	215–261 (IU/L)	>262 (IU/L)
eGFR (ml/min/1.73m^2)				
>120	reference	1.271	1.238	2.166
		(0.610–2.646)	(0.581–2.640)	(1.084–4.329)
90–119	reference	0.809	0.913	1.355
		(0.626–1.047)	(0.715–1.164)	(1.073–1.711)
60–89	reference	1.099	1.106	1.260
		(0.866–1.396)	(0.875–1.397)	(1.003–1.582)
<60	reference	0.455	0.544	0.699
		(0.229–0.902)	(0.293–1.012)	(0.375–1.197)

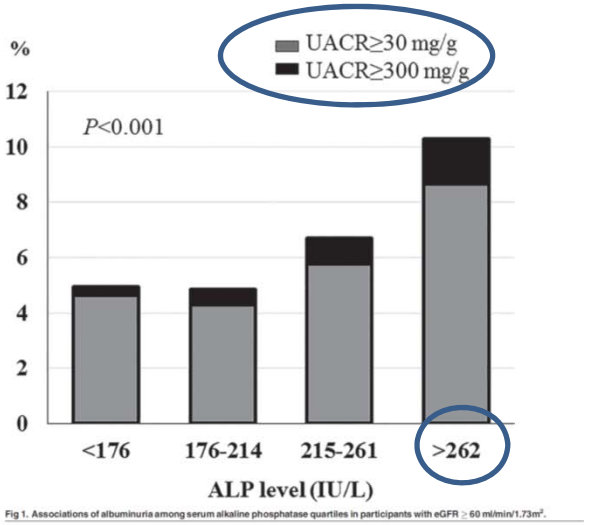


Fig 1. Associations of albuminuria among serum alkaline phosphatase quartiles in participants with eGFR ≥ 60 ml/min/1.73m^2.

Table 4. Associations of glomerular hyperfiltration among serum alkaline phosphatase quartiles in participants with an estimated glomerular filtration rate ≥ 60 ml/min/1.73 m^2.

Serum ALP quartiles*	OR	95% CI	P
<176 (IU/L)	reference		0.003
176–214 (IU/L)	1.254	0.939–1.675	0.126
215–261 (IU/L)	1.046	0.767–1.427	0.775
>262 (IU/L)	1.624	1.204–2.192	0.002
Hemoglobin	0.787	0.726–0.853	<0.001
Triglyceride	1.002	1.001–1.002	<0.001
WBC	1.109	1.048–1.173	<0.001
DM	1.516	1.017–2.261	0.041
Current smoking	1.466	1.124–1.912	0.005
Alcohol	1.347	1.076–1.685	0.009

Cohort study

Cohort study

- CRC for ESRD
  - Prospective study consisted of dialysis patients enrolled from September 1, 2008, at 31 centers in Korea
  - At least 20 years older, excluded if KT within 3 mos

- Know CKD
  - 9 nephrology centers in major university hospitals throughout Korea will enroll approximately 2,450 adults with chronic kidney disease over a 5-year period from 2011 to 2015.
  - The participating individuals will be monitored for approximately 10 years until death or until end-stage renal disease occurs.

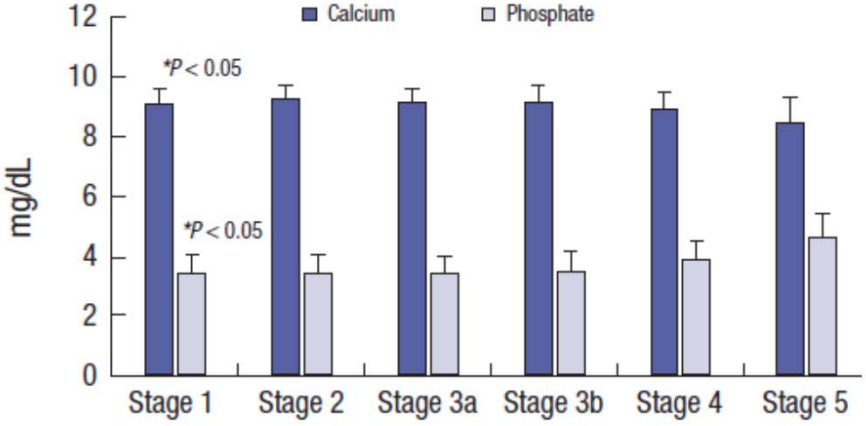
Chronic Kidney Disease-Mineral Bone Disorder in Korean Patients: a Report from the KoreaN Cohort Study for Outcomes in Patients With Chronic Kidney Disease (KNOW-CKD)

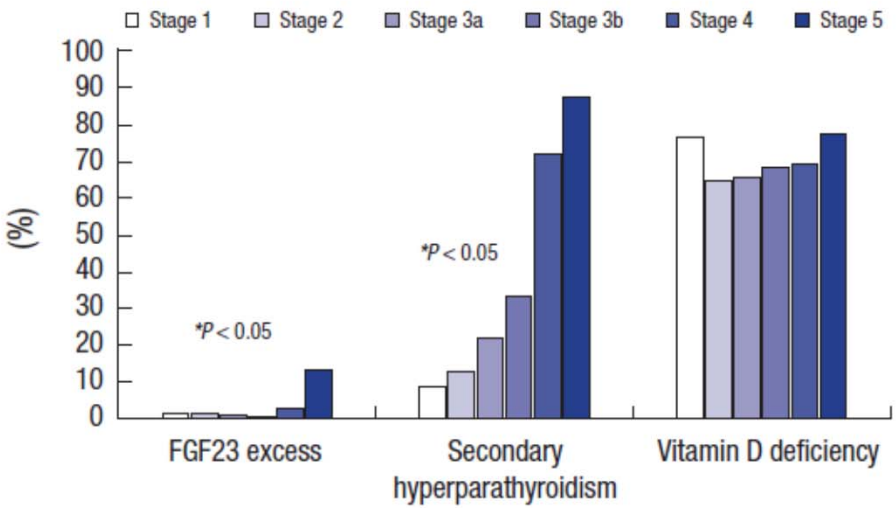
Kim CS, Kim SW et al. JKMS 2017

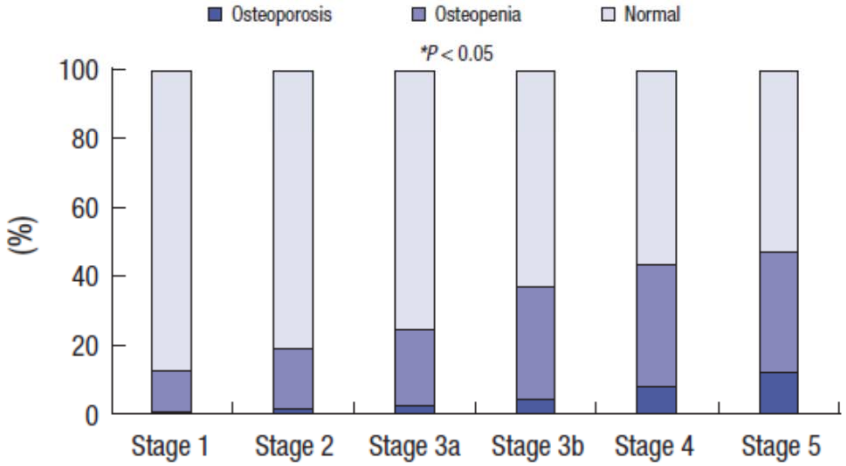
- Serum levels of FGF23, iPTH, 25-D, and 1,25-D; lumbar spine, total hip, and femur neck bone mineral densities and brachial-to-ankle pulse wave velocity (baPWV) measured at baseline for 2,238 CKD patients

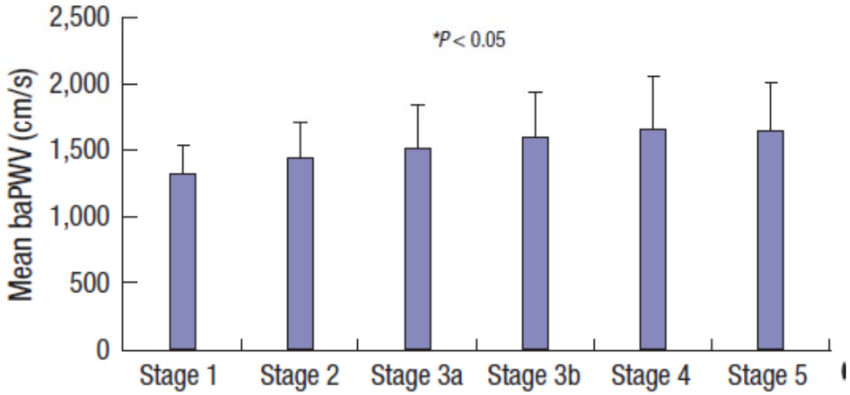
- a decline in serum vitamin D levels was observed in early CKD stages before significant increases of FGF23 and iPTH in the Korean CKD population compared with that in Western populations.

- Increased bone disease and vascular calcification occurred in early-stage CKD.


Calcium
Phosphate
mg/dL
12
10
8
6
4
2
0
*P < 0.05
*P < 0.05
Stage 1
Stage 2
Stage 3a
Stage 3b
Stage 4
Stage 5


Stage 1
Stage 2
Stage 3a
Stage 3b
Stage 4
Stage 5
(%)
100
90
80
70
60
50
40
30
20
10
0
*P < 0.05
*P < 0.05
FGF23 excess
Secondary hyperparathyroidism
Vitamin D deficiency

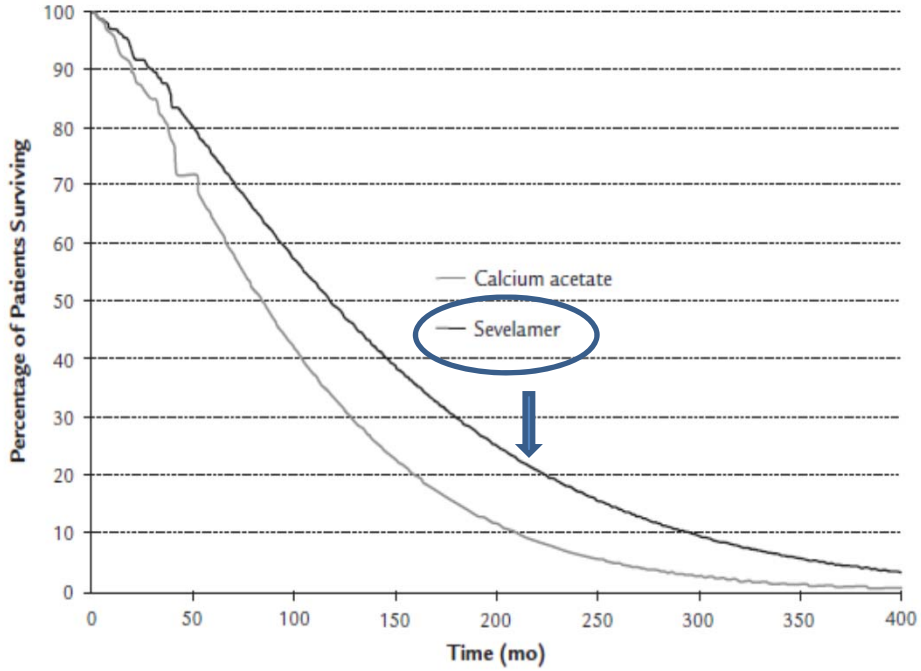

Osteoporosis
Osteopenia
Normal
*P < 0.05
(%)
100
80
60
40
20
0
Stage 1
Stage 2
Stage 3a
Stage 3b
Stage 4
Stage 5


*P < 0.05
Mean baPWV (cm/s)
2,500
2,000
1,500
1,000
500
0
Stage 1
Stage 2
Stage 3a
Stage 3b
Stage 4
Stage 5

A Real-world Cost-effectiveness Analysis of Sevelamer vs. Calcium Acetate in Korean Dialysis Patients

Cho JH, Kim YL et al, Clinical Therapeutics, 2017

- Data (demographic, diagnostic, laboratory, and survival) from 4674 patients undergoing dialysis enrolled in a multicenter prospective cohort study conducted in South Korea between September 2008 and December 2012
- Data were linked to phosphate binder use, hospitalization, and cost data available from the Health Insurance Review and Assessment Service database.
- After propensity score matching, a dataset comprising comparable patients treated with either sevelamer(n = 501) or calcium acetate(n = 501) was used in the cost-effectiveness analysis.
- A Markov model was used to estimate costs, life years, quality-adjusted life years (QALYs),and cost-effectiveness over each patient's lifetime.
- 40-mo treatment-specific overall survival(OS) data available from the dataset were extrapolated to lifetime survival with the use of regression analysis.



40-month treatment-specific overall survival from the Health Insurance Review and Assessment Service data base analysis (propensity score matched–patient population) extrapolated by using a Weibull regression analysis

Outcome	Calcium Acetate	Sevelamer	Incremental (Sevelamer – Calcium Acetate)
Total cost per patient	₩31,907,174 ($28,187)	₩44,154,085 ($39,005)	₩12,246,911 ($10,819)
Total life years per patient	6.5306	8.2886	1.7580
Total QALYs per patient	4.1143	5.2218	1.1075
Cost per life year gained (sevelamer vs calcium acetate)		₩6,966,350 ($6154)	
Cost per QALY gained (sevelamer vs calcium acetate)		₩11,057,699 ($9768)	

QALY = quality-adjusted life year.

Sex, Age, and the Association of Serum Phosphorus With All-Cause Mortality in Adults With Normal Kidney Function

Yoo KD, Lee H et al. AJKD 2016

- Cohort included 138,735 individuals undergoing voluntary routine health checkups in 3 tertiary hospitals - one in 1995 to 2006 and two in 2003 to 2009.
- The study included 92,756 individuals. During a median follow-up of 75 months, 1,646 participants died.
- In the overall population, higher serum phosphorus levels were an independent predictor for all-cause mortality after adjustment (adjusted HR for the highest vs lowest quartile, 1.34;95%CI, 1.15-1.56;P<0.001).
- We observed that this increased risk was present in men but not in women (adjusted HR of 1.43 [95% CI, 1.22-1.68] vs 1.01 [95% CI, 0.76-1.33]), but interaction by sex was not significant (P 5 0.8).

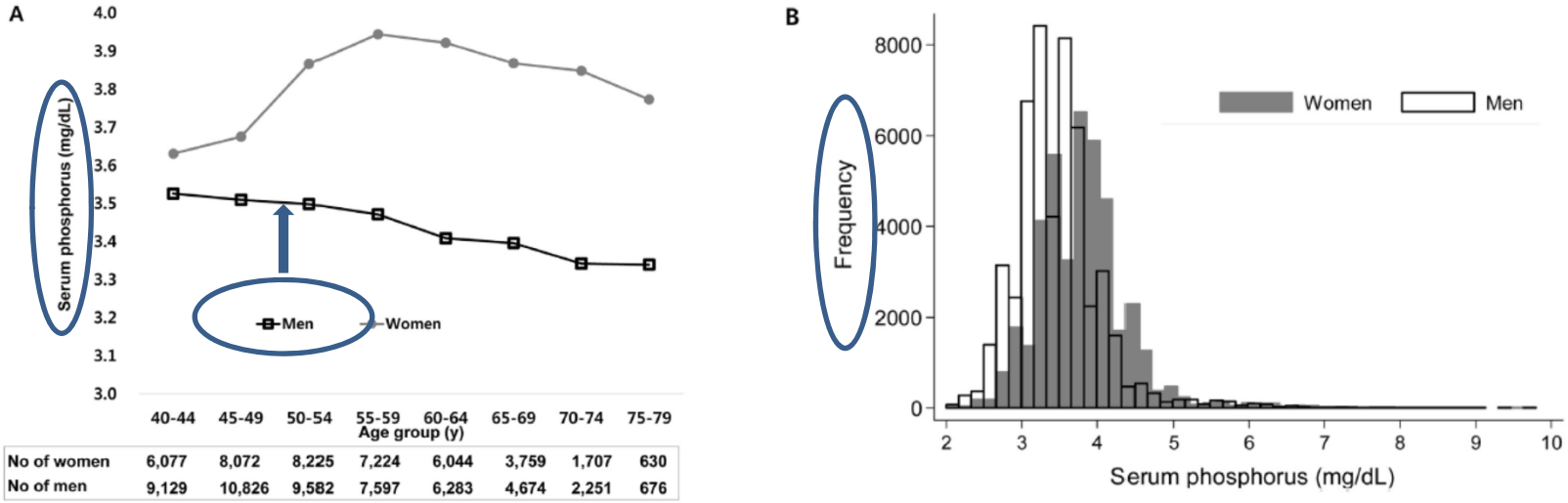


Table 4. Association of Serum Phosphorus Level and Mortality

		Unadjusted		Adjusted	
		HR (95% CI)	*P*	HR (95% CI)	*P*
Overall[a]	Q1	1.00 (reference)		1.00 (reference)	
	Q2	0.90 (0.79-1.03)	0.1	1.10 (0.96-1.26)	0.2
	Q3	0.85 (0.75-0.96)	0.01	1.19 (1.04-1.36)	0.01
	Q4	0.81 (0.70-0.92)	0.002	1.34 (1.15-1.56)	<0.001
Men[b]	Q1	1.00 (reference)		1.00 (reference)	
	Q2	0.98 (0.84-1.15)	0.8	1.10 (0.94-1.29)	0.2
	Q3	1.05 (0.89-1.23)	0.6	1.26 (1.07-1.48)	0.005
	Q4	1.09 (0.94-1.28)	0.3	1.43 (1.22-1.68)	<0.001
Women[c]	Q1	1.00 (reference)		1.00 (reference)	
	Q2	1.34 (1.03-1.75)	0.03	1.14 (0.87-1.49)	0.3
	Q3	1.08 (0.83-1.42)	0.6	0.84 (0.64-1.11)	0.2
	Q4	1.31 (1.00-1.73)	0.05	1.01 (0.76-1.33)	0.9

Abbreviations: BMI, body mass index; BP, blood pressure; CI, confidence interval; eGFR, estimated glomerular filtration rate; HR, hazard ratio; Q, quartile of phosphorus.

[a]In overall population, we adjusted for age, sex, diabetes, hypertension, BMI, calcium level, albumin level, hemoglobin level, glucose level, systolic BP, albuminuria by dipstick test, smoking history, and eGFR. Sex showed no significant interaction for the serum phosphorus–mortality association (*P* for interaction = 0.8).

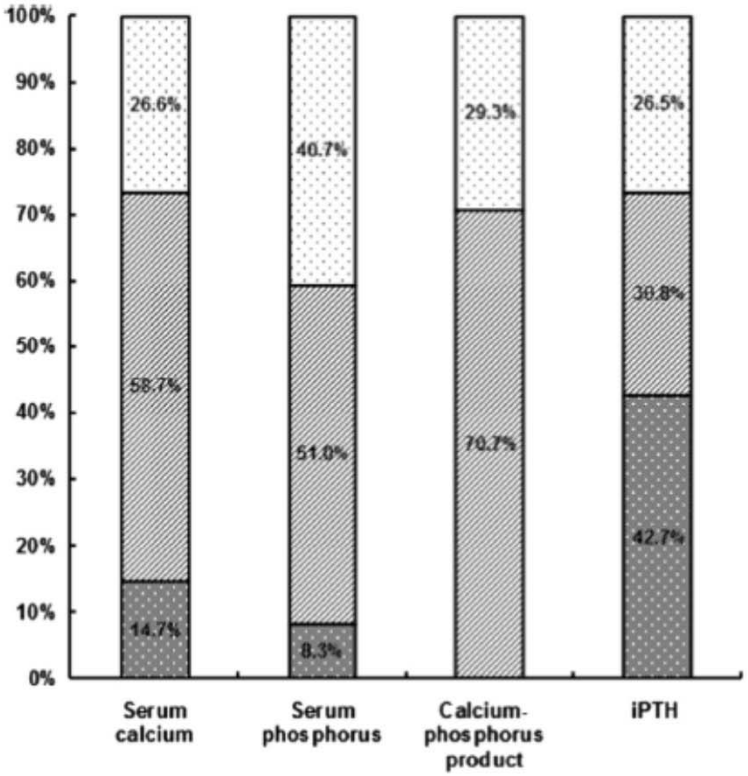
Cross sectional study

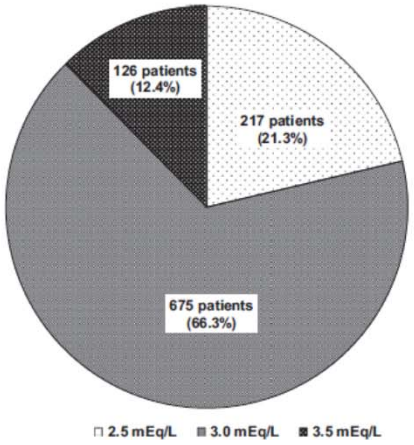
Serum calcium and phosphorus levels in patients undergoing maintenance hemodialysis: A multicentre study in Korea

Kim GH, Kwon YJ et al, Kidney Research and Clinical Practice 2013

- Collected from a total of 1,018 patients undergoing MHD without intercurrent illness, in 17 hemodialysis centers throughout the country

Serum parameters	Phosphate binders				*P*
	Combined use ($n = 306$)	Calcium-based agents ($n = 329$)	Calcium-free agents ($n = 101$)	No use ($n = 282$)	
Calcium (mg/dL)	9.0 ± 0.6	9.0 ± 0.6	9.6 ± 0.9	9.2 ± 0.9	<0.0001*
Phosphorus (mg/dL)	5.9 ± 1.1	4.7 ± 1.1	6.2 ± 1.2	5.0 ± 1.5	<0.0001*
Calcium-phosphorus product (mg^2/dL^2)	52.9 ± 10.4	41.7 ± 10.3	59.5 ± 12.7	45.8 ± 15.7	<0.0001*
iPTH (pg/mL)	262.6 ± 247.9	203.0 ± 226.6	370.9 ± 315.5	291.3 ± 389.7	<0.0001†





Vitamin D receptor agonists	iPTH (pg/mL)		
	< 150 ($n = 435$)	150~300 ($n = 313$)	> 300 ($n = 270$)
Alfacalcidol	19 (1.9)	28 (2.8)	10 (1.0)
Calcitriol	55 (5.4)	138 (13.6)	99 (9.7)
Paricalcitol	1 (0.1)	7 (0.7)	30 (3.0)
Alfacalcidol + calcitriol	0 (0.0)	5 (0.5)	6 (0.6)
Paricalcitol + others	0 (0.0)	13 (1.3)	56 (5.5)
No treatment	360 (35.4)	122 (12.0)	69 (6.8)

Association between Vitamin D Deficiency and Anemia in Patients with End-Stage Renal Disease: A Cross-Sectional Study

Kim YL, Kang SW et al. Yonsei Med J 2016

- From medical records of 410 ESRD patients who had undergone renal transplantation (RTx) at Yonsei University Health System and who had 25(OH)D3 levels measured at the time of RTx

- Patients were divided into two groups based on baseline 25(OH)D3 concentrations: group 1, 25(OH)D3 levels <10 ng/mL; and group 2, 25(OH)D3 levels ≥10 ng/mL.

- Using multivariate regression models, 25(OH)D3, age, and erythrocyte-stimulating agent (ESA) dose were found to be significantly associated with hemoglobin (Hb) levels [25(OH)D3: β=0.263, p<0.001; age: β=0.122, p=0.010; ESA dose: β=-0.069, p=0.005].

- Risk Factors for Developing Anemia (Hb <10 g/dL)

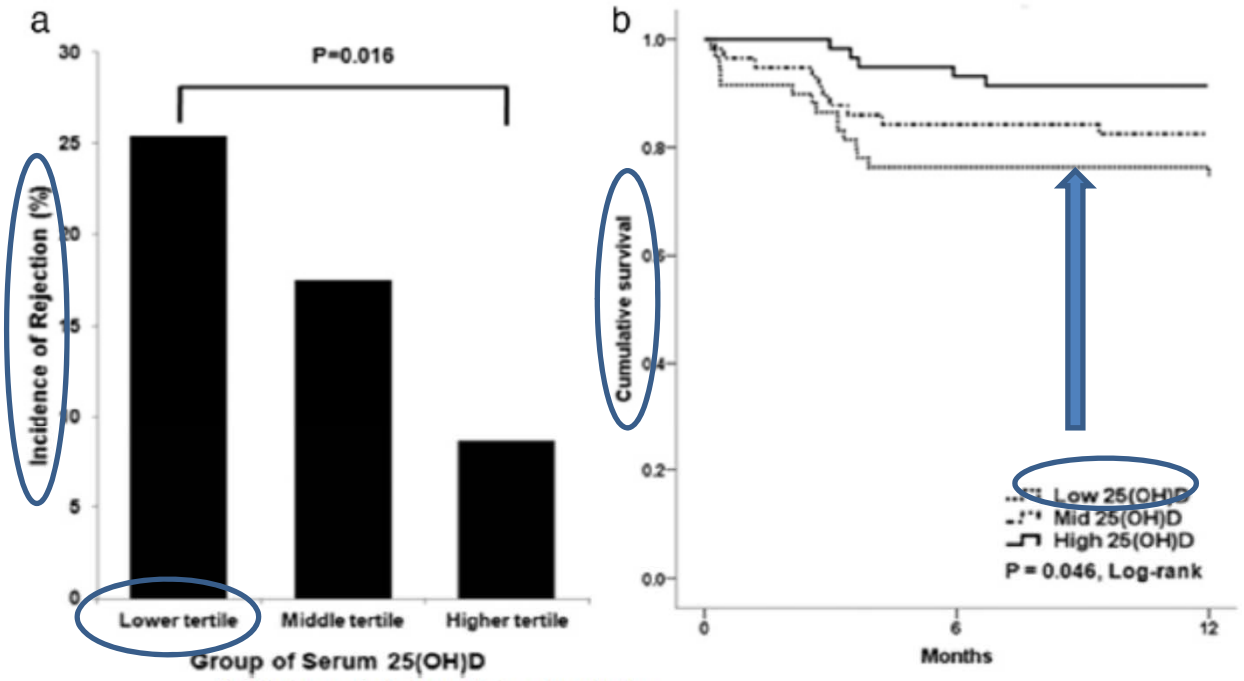
Variable	OR (95% CI)	*p* value
25(OH)D3 <10 vs. ≥10	3.857 (1.091–13.632)	0.036
Age (per 1-year increase)	0.971 (0.919–1.027)	0.307
ESA dose (per 1-unit increase)	1.000 (1.000–1.000)	0.211
Log iPTH (per 1-pg/mL increase)	1.440 (0.807–2.569)	0.217
Phosphate (per 1-mg/dL increase)	0.815 (0.498–1.334)	0.417
ALP (per 1-IU/L increase)	1.005 (0.979–1.032)	0.689
Log hs-CRP (per 1-mg/L increase)	0.890 (0.515–1.539)	0.677
Ferritin (per 1-ng/mL increase)	0.996 (0.992–1.001)	0.132
Serum iron (per 1-ug/dL increase)	1.003 (0.987–1.020)	0.715
TIBC (per 1-ug/dL increase)	0.998 (0.987–1.009)	0.706
TSAT (per 1% increase)	0.312 (0.034–2.875)	0.304
Sex (male vs. female)	0.184 (0.033–1.015)	0.052
Diabetes (yes vs. no)	0.337 (0.080–1.418)	0.138
Smoking (yes vs. no)	0.215 (0.041–1.142)	0.071

Clinical effects of pre-transplant serum 25-hydroxyvitamin D level on post-transplant immunologic and non-immunologic outcomes in kidney transplant recipients

Ban TH, Chung BH et al. Transplantation Immunology 2016

- 174 KTRs with low immunologic risk at baseline. We divided the patients into three groups according to baseline serum 25(OH)D level and compared the post-transplant clinical outcomes of acute rejection, infectious complications, and osteoporosis among the groups.

- Thirty cases of biopsy-proven acute rejection (BPAR) were detected during the first year after KT. In the highest tertile, the rate of acute rejection (8.6%) was significantly lower than that in the lowest tertile (25.4%) (p=0.016), and a high 25(OH)D level was independently associated with a low incidence of BPAR inmultivariate analysis.



Risk factor analysis to predict acute rejection.

	Univariate analysis			Multivariate analysis		
	HR	95% CI	*p*	HR	95% CI	*p*
Male	1.13	0.44–2.90	0.80			
Age (years)	0.96	0.92–1.00	0.07			
ABOi	1.15	0.40–3.27	0.80			
HLA MN	1.50	1.13–2.00	<0.01	1.41	1.11–1.81	<0.01
DM	0.43	0.10–1.80	0.25			
HTN	0.64	0.26–1.62	0.35			
25(OH)D, middle	0.32	0.12–0.83	0.02	0.43	0.19–0.99	0.047
25(OH)D, high	0.10	0.03–0.43	<0.01	0.11	0.03–0.40	<0.01
Osteoporosis	0.63	0.27–1.51	0.30			
iPTH	1.00	0.997–1.002	0.75			
Hb	1.12	0.87–1.45	0.37			
Cr	0.98	0.84–1.14	0.79			
Ca	0.64	0.36–1.17	0.15			
P	0.87	0.63–1.19	0.38			
TC	0.96	0.93–1.00	0.06			
TG	1.00	0.99–1.01	0.81			
LDL	1.04	0.99–1.09	0.12			

Asymptomatic hyperuricemia is independently associated with coronary artery calcification in the absence of overt coronary artery disease
A single-center cross-sectional study

Kim HW, Park HC et al. Medicine 2017

- A total of 4188 individuals without prior coronary artery disease or urate-deposition disease were included.
- All of the participants underwent multidetector computed tomography (MDCT) for the evaluation of coronary artery calcification (CAC) during their health check-ups.

- The subjects were divided into thre groups according to CAC scores (group 1: 0; group 2: 1–299; group 3:≥300).

- After controlling for other confounders, serum UA levels were found to be positively associated with increasing CAC scores (P=0.001).
- Adjusted mean serum UA levels in each CAC group were estimated to be 5.2±0.1mg/dL, 5.3±0.1mg/dL, and 5.6±0.2mg/dL from groups 1, 2, and 3, respectively.

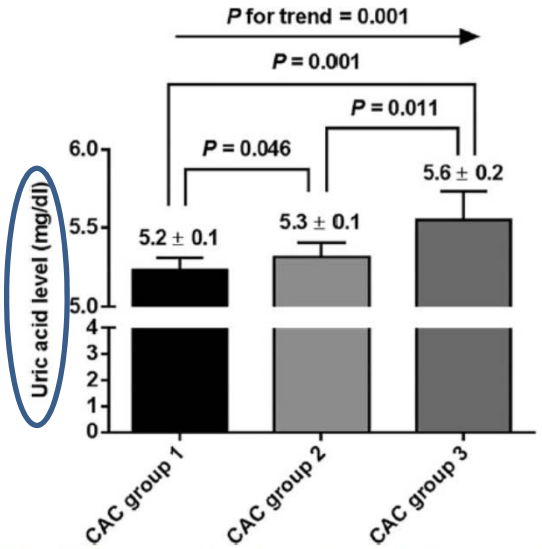


Figure 2. The multivariate-adjusted estimated mean levels of serum uric acid in each CAC group. CAC = coronary artery calcification.

The multivariate-adjusted associations between serum uric acid level and CAC groups in subgroups from linear regression analysis.

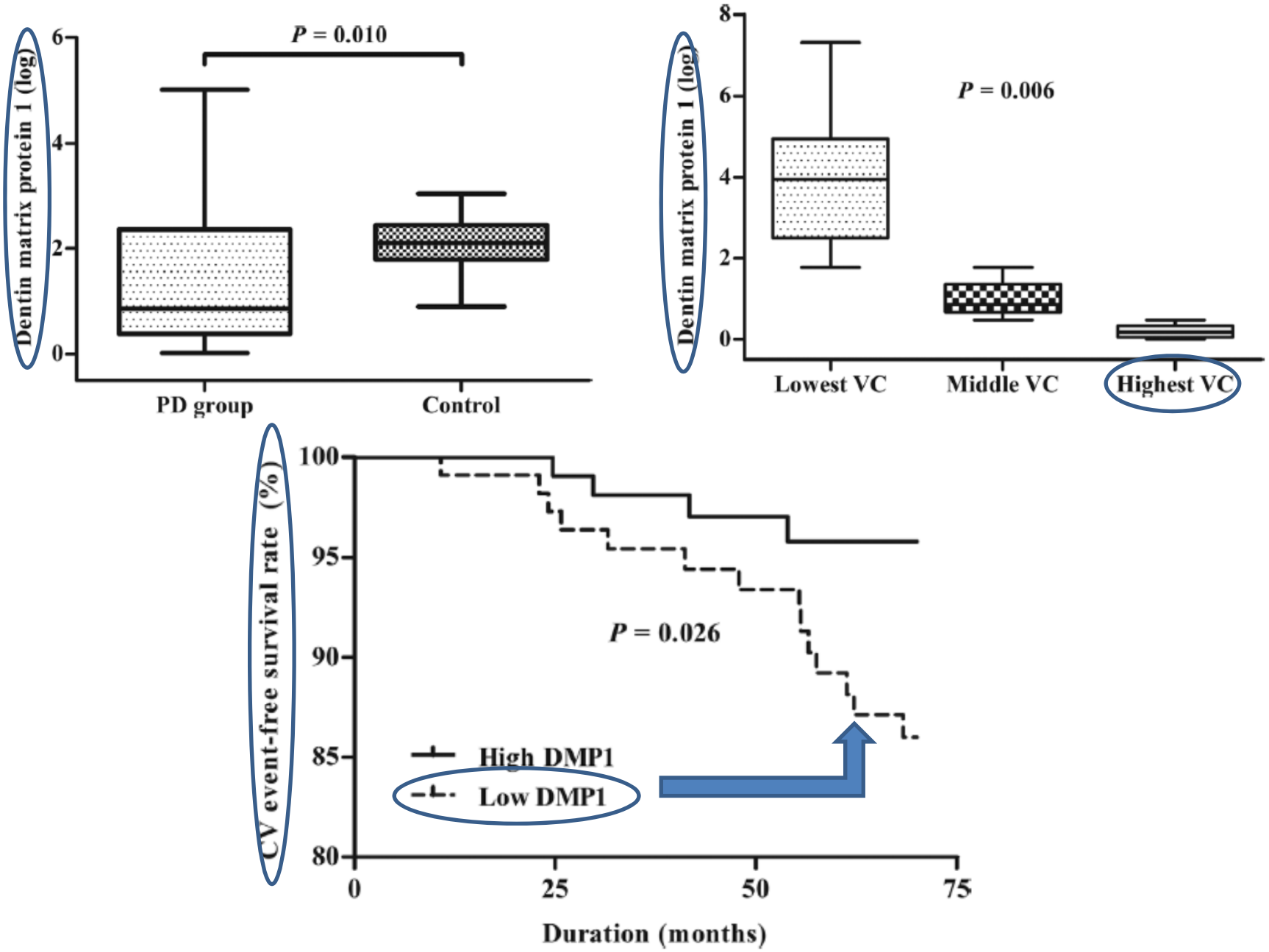
Subgroups	Number of the patients (%)	*B*	SE	*P*-values
Age ≥53 years (the median age)	2236 (53.4)	0.168	0.041	<0.001
Age <53 years (the median age)	1952 (46.6)	0.007	0.067	0.911
Male	2559 (61.1)	0.153	0.044	<0.001
Female	1629 (38.9)	0.050	0.056	0.373
With diabetes mellitus	304 (7.3)	0.054	0.102	0.599
Without diabetes mellitus	3884 (92.7)	0.125	0.037	0.001
With hypertension	856 (20.4)	0.087	0.069	0.210
Without hypertension	3332 (79.6)	0.123	0.040	0.002
With ever smoking	721 (17.2)	0.118	0.075	0.114
Without ever smoking	3467 (82.8)	0.105	0.039	0.007
With renal dysfunction	94 (2.2)	0.427	0.250	0.092
Without renal dysfunction	4094 (97.8)	0.102	0.035	0.003
BMI ≥25 kg/m^2	1490 (35.6)	0.048	0.058	0.404
BMI <25 kg/m^2	2698 (64.4)	0.166	0.043	<0.001

Low Dentin Matrix Protein 1 Is Associated With Incident Cardiovascular Events in Peritoneal Dialysis Patients

Yoon CH, Yoo TH et al, JBMR 2016

- 223 prevalent peritoneal dialysis patients and divided them into high and low DMP1 groups according to log-transformed plasma DMP1 levels.
- Lateral lumbar spine radiographs were used for measurement of vascular calcification. Major cardiovascular events were compared between the two groups.
- A Cox proportional hazards analysis determined DMP1 was independently associated with cardiovascular outcomes.

- The multiple logistic regression analysis indicated that DMP1 levels were independently associated with the presence of vascular calcification after adjustment for multiple confounding factors (odds ratio=0.719; 95% confidence interval [CI] 0.522–0.989; p=0.043). During a mean follow-up duration of 34.6 months, incident cardiovascular events were observed in 41 (18.4%) patients. A Kaplan-Meier plot showed that the low DMP1 group had a significantly higher rate of incident cardiovascular events compared with the high DMP1 group (log-rank test, p=0.026). In addition, multiple Cox analysis showed that low DMP1 was significantly associated with incident cardiovascular events (log 1 increase: hazard ratio=0.855; 95% CI 0.743–0.984; p=0.029) after adjustment for multiple confounding factors.


Dentin matrix protein 1 (log)
P = 0.010
PD group
Control
Dentin matrix protein 1 (log)
P = 0.006
Lowest VC
Middle VC
Highest VC
CV event-free survival rate (%)
P = 0.026
High DMP1
Low DMP1
Duration (months)

Clinical trials

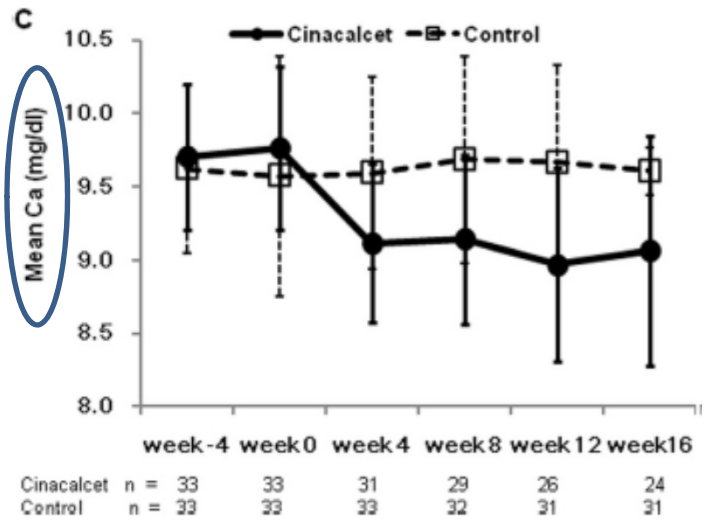
Cinacalcet lowering of serum fibroblast growth factor-23 concentration may be independent from serum Ca, P, PTH and dose of active vitamin D in peritoneal dialysis patients: a randomized controlled study

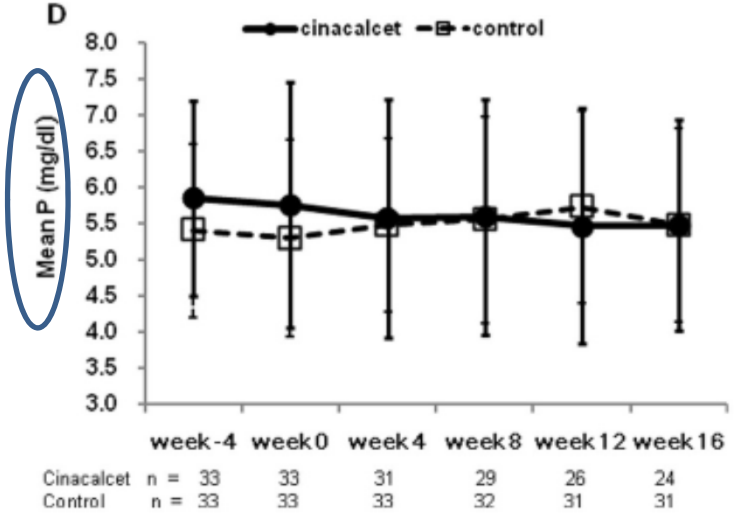
Kim HJ, Oh KW et al. BMC nephrology 2013

- Multicenter, open-labeled, randomized controlled study
- Overall, 66 peritoneal dialysis patients were enrolled

- Achievement of >30% reduction of iPTH from baseline NKF-K/DOQI targets(primary) and FGF23 reduction (secondary).

- Randomly assigned to treatment with either cinacalcet + oral vitamin D (cinacalcet group, n = 33) or oral vitamin D alone (control group, n = 33)
- a 4-week screening for vitamin D washout, a 12-week dose-titration, and a 4-week assessment phases.





- Cinacalcet group received 30.2 ± 18.0 mg/day of cinacalcet and 0.13 ± 0.32 μg/d oral vitamin D ($P < 0.001$ vs. control with 0.27 ± 0.18 μg/d vitamin D).
- The proportion of patients who reached the primary endpoint was not statistically different (48.5% vs. 51.5%, cinacalcet vs. control, $P = 1.000$).
- After adjustment, cinacalcet treatment was independently associated with the serum FGF23 reduction.

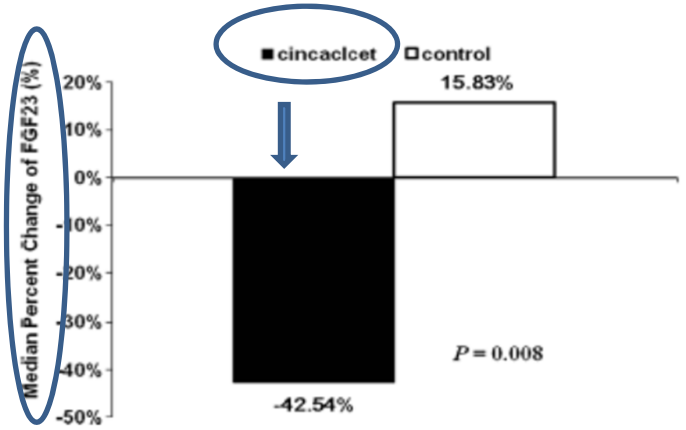


Table 3 Univariate and multivariate linear regression analysis for association of the percent change in square root FGF23 with treatment groups

	B coefficient* (95% CI)	*P*- value
Univariate analysis	−42.45 (−70.96 to −13.93)	0.004
Multivariate analysis†	−43.58 (−73.07 to −14.09)	0.005

* Treatment effect was analyzed by cinacalcet versus control.

Diameter of Parathyroid Glands Measured by Computed Tomography as a Predictive Indicator for Response to Cinacalcet in Dialysis Patients with Secondary Hyperparathyroidism

Hong YA, Kwon YJ et al. Kidney Blood Press Res 2015

- In study 1, we compared the predictive cutoff values of the largest volume or diameter of PTGs on ultrasonography or CT for achievement of target intact parathyroid hormone (iPTH) level according to K/DOQI guideline after cinacalcet treatment 26 patients in a single dialysis center.

- In study 2, the role of the cutoff diameter of PTGs on CT in predicting responsive to cinacalcet therapy was reevaluated in dialysis patients with SHPT in 82 patients in multiple centers.

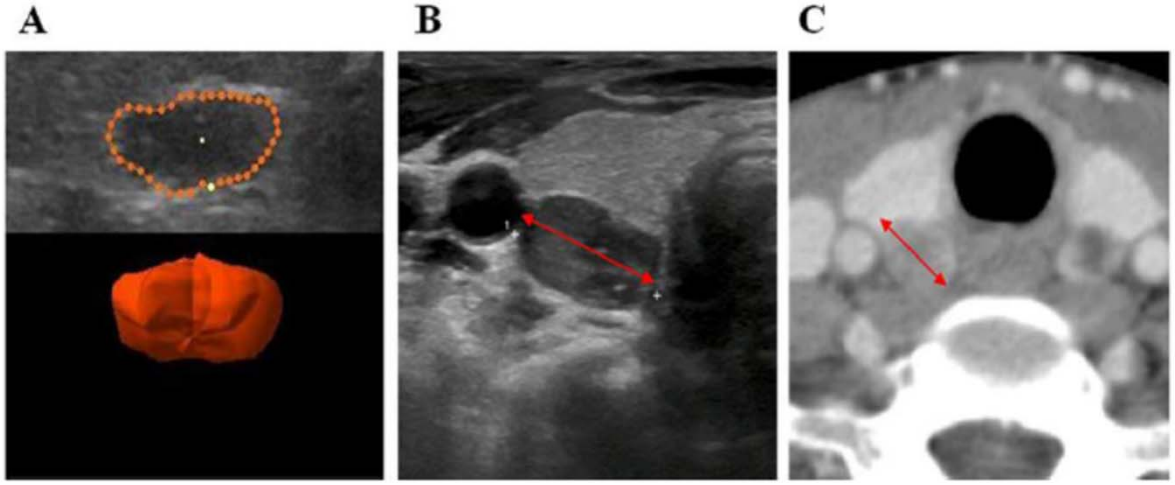


Table 2. Comparisons of serum iPTH before and after cinacalcet treatment and change (Δ) in iPTH according to parathyroid gland length on CT or volume and length on US in a single center (Study 1)

Gland	Number of PTGs		p value
1) CT (length)	larger than or equal to cutoff value (11.2 mm)		
	0	1 or more	
Pre-iPTH (pg/mL)	465±55	850±386	<0.001***
Post-iPTH (pg/mL)	187±37	516±508	0.010**
Δ iPTH (pg/mL)	-278±29	-333±414	0.560
2) US (volume)	larger than or equal to cutoff value (475 mm^3)		
	0	1 or more	
Pre-iPTH (pg/mL)	764±363	808±415	0.786
Post-iPTH (pg/mL)	361±402	562±544	0.315
Δ iPTH (pg/mL)	-403±425	-246±321	0.318
3) US (length)	larger than or equal to cutoff value (16.4 mm)		
	0	1 or more	
Pre-iPTH (pg/mL)	806±428	745±290	0.719
Post-iPTH (pg/mL)	475±573	435±218	0.849
Δ iPTH (pg/mL)	-331±408	-311±331	0.903

Values calculated by Mann-Whitney *U* test. * p< 0.05, ** p < 0.005, *** p < 0.001. CT, computed tomography; iPTH, intact parathyroid hormone; ultrasonography PTG, parathyroid gland; US,

. Clinical factors influencing the response to cinacalcet treatment in SHPT in a multicenter study (Study 2)

Variable	Univariate		Multivariate	
	Odds Ratio (95% CI)	p value	Odds Ratio (95% CI)	p value
Age (per 1 year)	0.972 (0.935-1.011)	0.158		
Male	1.161 (0.459-2.937)	0.752		
Dialysis duration (per 1 year)	1.003 (0.996-1.010)	0.411		
Diabetes	0.485 (0.122-1.926)	0.485		
BMI		0.695		
<25	0.400 (0.026-6.176)			
25-30	1.125 (0.187-6.758)			
>30	1.600 (0.231-11.082)			
iPTH (per 100 pg/mL)	1.304 (1.111-1.530)	0.001	1.498 (1.15-1.952)	0.003**
Corrected Ca (per 1 mg/dL)	1.452 (0.840-2.507)	0.181		
Phosphorus (per 1 mg/dL)	1.146 (0.861-1.526)	0.351		
ALP (per 1 IU/L)	1.000 (0.999-1.002)	0.670		
Existence of enlarged PTGs ≥ 11.2 mm on CT	5.58 (1.706-18.257)	0.004	8.940 (1.533-52.142)	0.015*

Values calculated by logistic regression. * p < 0.05, ** p < 0.005, *** p < 0.001, CI, confidence interval, ALP, alkaline phosphatase; BMI, body mass index; Ca, calcium; CT, computed tomography; HD, hemodialysis; iPTH, intact parathyroid hormone; PTG, parathyroid gland

National guideline

Korean working group recommendations

- CKD stage 5D

- Global & local guidelines
- National reimbursement
- Expert opinions
- Korean Society of Nephrology Registry

Contents of Korean working group recommendations

- Measurement of serum Ca, P, and iPTH
  - Consideration of dialysate Ca concentration
- Dietary P restriction
- Treatment of hyperphosphatemia
  - P removal through dialysis
  - Use of phosphate binders
- Treatment of secondary hyperparathyroidism
  - Medical treatment
    - VDRAs / Cinacalcet
    - Selection of VDRAs and/or cinacalcet, based on the serum Ca levels
      - Serum Ca o 8.4 mg/dL / Serum Ca 8.4–9.0 mg/dL /Serum Ca 9.0–10.2 mg/dL / Serum Ca 4 10.2 mg/dL
  - Surgical treatment

Target levels of Ca, P, & PTH

	Phosphorus (mg/dL)	Calcium (mg/dL)	Intact parathyroid hormone (pg/mL)
KDIGO [7]	Towards normal range	Towards normal range	2–9 × normal range
ERBP [11]	2.4–4.5	Towards normal range	100–800
UKRA [10]	2.78–4.64	8.8–10.0	Not mentioned
CARI [8]	~4.95	8.5–10.5	100–470
KDOQI [6]	3.5–5.5	8.4–9.5	150–300
JSDT [9]	3.5–6.0	8.4–10.0	60–240

KDIGO method :
Corrected total Ca (mg/dL) = measured Ca (mg/dL) + 0.8 x [4 – s-alb (g/dL)]
JSDT method :
Corrected total Ca (mg/dL) = measured Ca (mg/dL) + [4 – s- albumin (g/dL)]

Korean working group recommendations: measurement frequency & ranges of serum Ca, P, and PTH in CKD stage 5D

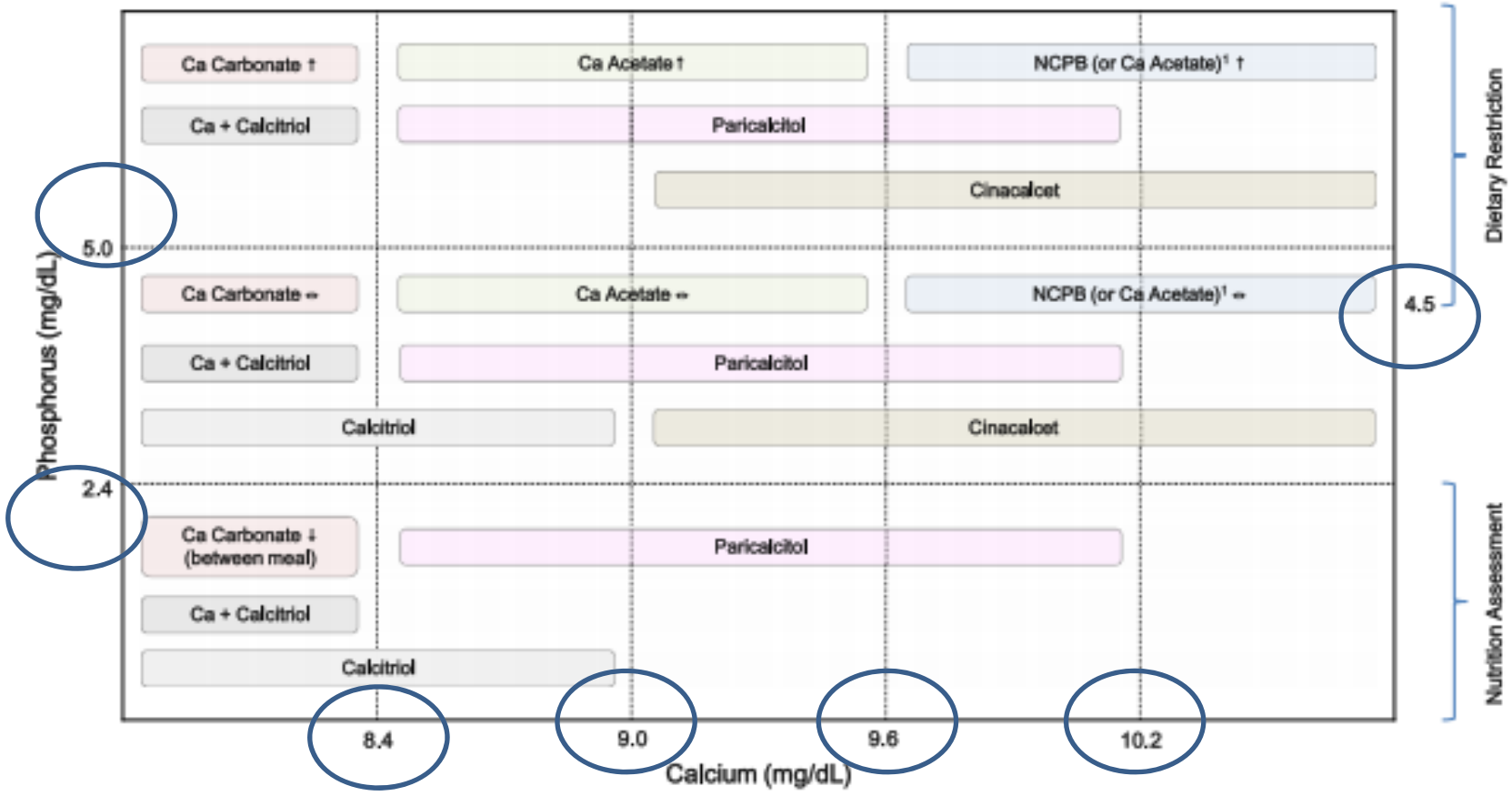
Serum parameters	Measurement frequency	Recommended range
Calcium	Once per mo	8.4–9.6 mg/dL
Phosphorus	Once per mo	2.4–5.0 mg/dL
Parathyroid hormone	Once every 3 mo	100–300 pg/mL

Web & App.

Food	Common measure (g)	Phosphorus content (mg)	Protein content (g)	Phosphorus (mg) / protein (g) ratio
Chicken, leg, meat only, fried or fired	60	115.8	17.0	4.1
Chicken, breast, meat only, fried	60	148		
Pork, ribs, roasted	60	135		
Pork, belly	60	79		
Beef, Korean cattle, loin	60	99		
Beef, imported cattle, brisket, braised	60	112		
Mackerel, broiled	60	144		
Spanish mackerel, broiled	60	156		
Chum salmon, smoked	60	141		
Chicken's egg, broiled	60	123		
Soybean curd, pressed	80	72		
Potatoes, steamed	100	35		
Sweet potatoes, steamed	100	40		
Chestnuts, raw	60	40.8	1.9	12.8
Peanuts, dried	10	39.8	2.5	1.6
Milk, ordinary liquid milk	200	178.0	6.4	55.6
Yogurt, liquid type	150	93.0	2.3	62.0

Adapted with permission from the Nutritious Food Table, 8th Revision, 2011, National Academy of Agricultural Science.

Summary of the treatment strategy for control of SHPT according to the level of serum Ca and P



Future plan

- QI for Korean Working Group Recommendations
  - 2017 KSN
  - 1,000 pts in teaching hospital
  - 6 mos – before and after recommendation

- Morbidity & mortality analysis for KSN Registry
  - From 2012 to 2014
  - Morbidity & mortality report until 2016
  - Analysis 2017

- Reevaluate Korean Working Group Recommendations
  - From 2018 to 2019