

Diabetes & Chronic Kidney Disease: what's the connection?

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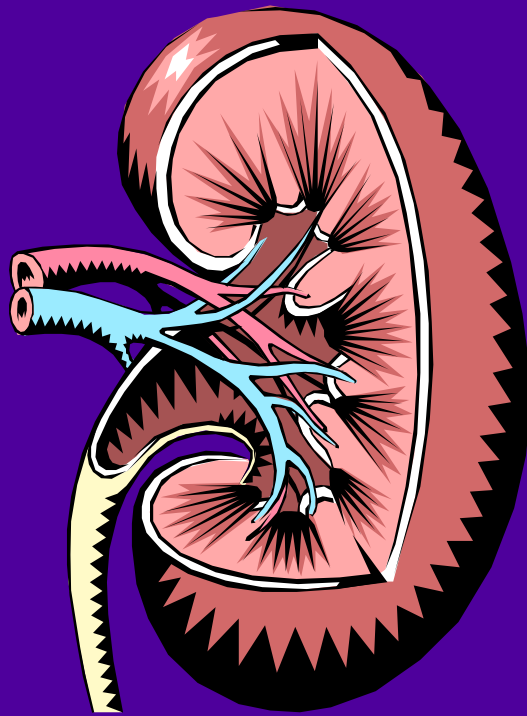
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Outline

- Kidney anatomy & functions.
 - What is chronic kidney disease.
 - Why study CKD & diabetes.
 - Assessment of kidney disease & damage.
 - Goals of early treatment
 - Current Treatment Practices
 - Conclusions
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Kidneys



- ❑ Bean shaped organs
- ❑ Highly vascular
- ❑ Comprised of four elements
- ❑ Each kidney contains 1 million nephrons
- ❑ Damage causes hypertrophy to remaining nephrons



Kidney Functions

- Removal of metabolic wastes
 - Fluid and electrolyte balance
 - Acid – Base regulation
 - Blood pressure Control:
 - Renin angiotensin system
 - Aldosterone
 - Hormone production
 - Erythropoietin
 - Vitamin D regulation
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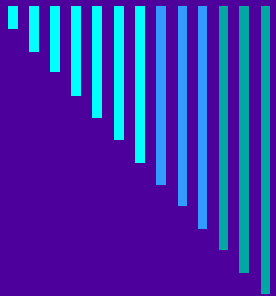
Chronic Kidney Disease

- National Kidney Foundation defines chronic kidney disease (CKD) as either damage to the kidney or a glomerular filtration rate < 60 ml/min/1.73 m² for more than 3 months.
 - Kidney damage: any pathological irregularity or markers of damage, such as abnormalities in blood, urine tests or imaging.
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Chronic Kidney Disease

- CRF: Chronic Renal Failure
 - CRI: Chronic Renal Insufficiency
 - ESRD: End Stage Renal Disease
 - Develops when kidneys permanently lose most of their ability to remove waste products and maintain fluid and chemical balances inside the body.
 - May occur rapidly over months or progress slowly over years.
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Stages of Chronic Kidney Disease

Stage	GFR (mL/min/1.73 m ²)	Description
1	≥90	Kidney damage,* N or ↑ GFR
2	60-89	Kidney damage,* mild or ↓ GFR
3	30-59	Moderate ↓ GFR
4	15-29	Severe ↓ GFR
5	<15	Kidney failure

*Kidney damage is defined as structural or functional abnormalities of the kidney manifested by pathological abnormalities or markers of kidney damage such as abnormal urine analysis or renal imaging.

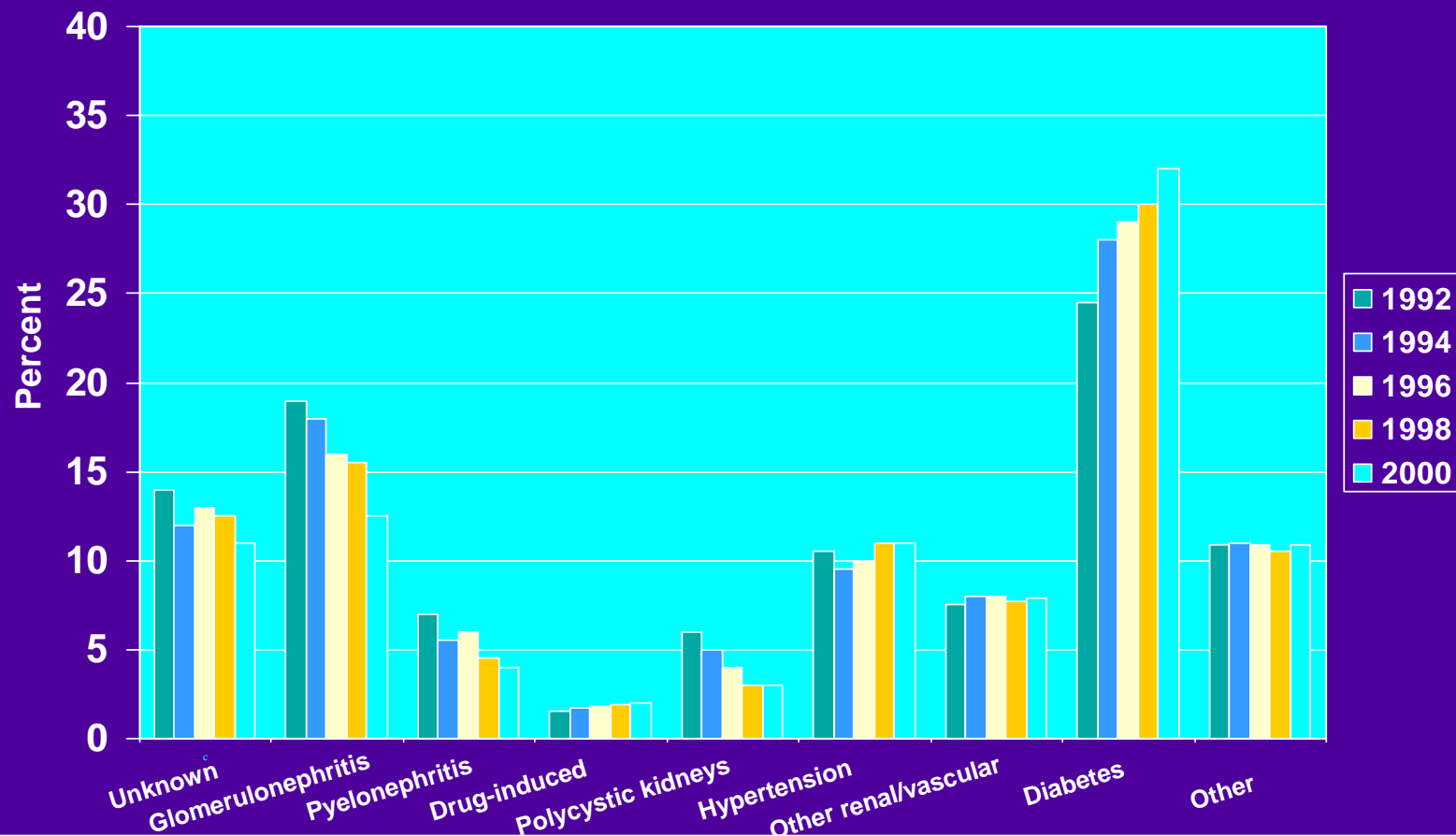
GFR=glomerular filtration rate
N=normal



Epidemiology of Diabetes Worldwide

- Over 177 million people with diabetes worldwide in 2000
- Expected to top 300 million by 2025
- About 90% have type 2 diabetes
- Cardiovascular disease, peripheral vascular disease, diabetic nephropathy, ESRD and stroke are among the complications associated with diabetes

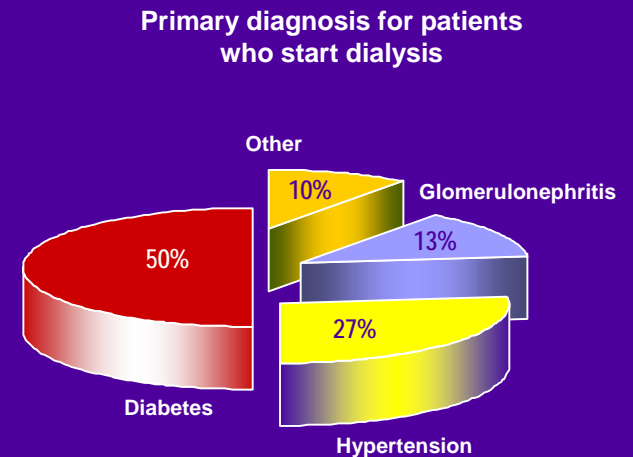
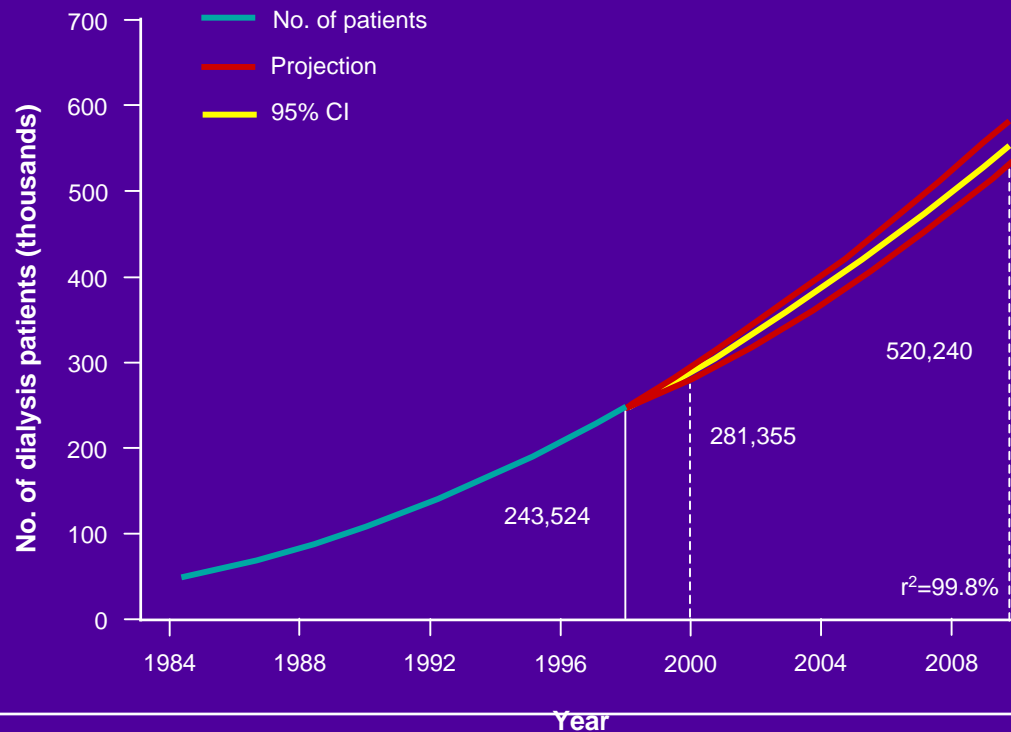
Primary Renal Disease in Canada



*Actual numbers are shown for 2000. Approximately 129 new patients have not been registered (69 in Quebec, 22 in Ontario and 38 in Alberta). The estimated total for Canada is 4,515.

Epidemiology of Diabetic Nephropathy

Most common causes of ESRD



ESRD=end stage renal disease
CI=confidence interval

USRDS 2000.



Diabetic Nephropathy: progressive decline

- Most common cause of renal failure in the Western world
- Progressive decline in renal function
 - Microalbuminuria (30-300 mg/day)
 - Macroalbuminuria (>300 mg/day)
- Typically identified in macroalbuminuria stage
- Can progress to ESRD
- Associated with CV morbidity and mortality

ESRD=end stage renal disease
CV=cardiovascular



Diabetic Nephropathy

- Interaction of metabolic and hemodynamic factors
- Metabolic factors
 - Uncontrolled hyperglycemia
- Hemodynamic factors
 - Systemic hypertension
 - Intraglomerular hypertension
 - Role of vasoactive hormones such as angiotensin II



Evaluating CKD

- Glomerular Filtration Rate (GFR)
 - Volume of blood filtered by the glomerulus each minute.
 - Healthy young adult GFR 120 -125 ml/min.
 - Clearance: determined by the volume of blood completely cleared of a particular substance within a given period of time.
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Serum creatinine vs. creatinine clearance

- Serum creatinine may falsely indicate renal function is normal
 - People can lose up to 50% of creatinine clearance before serum creatinine levels rise to abnormal range
- Assess renal function with creatinine clearance measured by formula such as Cockcroft-Gault or MDRD
 - Annually in those with diabetes, without nephropathy
 - Every 6 months in those with nephropathy



Calculated GFR: Cockcroft and Gault

- In men:

$$\text{Creatinine clearance} = \frac{(140 - \text{age}) \times \text{weight in kg}}{(72 \times \text{serum creatinine})}$$

- In women:

$$\text{Creatinine clearance} = \frac{(140 - \text{age}) \times \text{weight in kg}}{(72 \times \text{serum creatinine})} \times 0.85$$

GFR=glomerular filtration rate



Calculated eGFR: MDRD

- $GFR = 186 \times (\text{serum creatinine } [\mu\text{ mol/L}]/88.4)^{-1.154} \times \text{age (years)}^{-0.203} \times 0.742 \text{ (if female)}$
- See www.mdrd.com for an online calculator



Evaluating CKD: Urine Tests

- Albumin Creatinine Ratio (ACR):

 - Random urine collection to measure the quantity of albumin in the urine:
 - Normal urine albumin < 30 mg/ day
 - Microalbuminuria 30 -300 mg/ day
 - Macroalbuminuria > 300 mg/day
-



Evaluating CKD

- Signs & symptoms of ESRD
 - Lack of energy & fatigue
 - Edema & SOB
 - Hypertension
 - Sleep disorders
 - Nausea & vomiting
 - Loss of appetite
 - Weight loss
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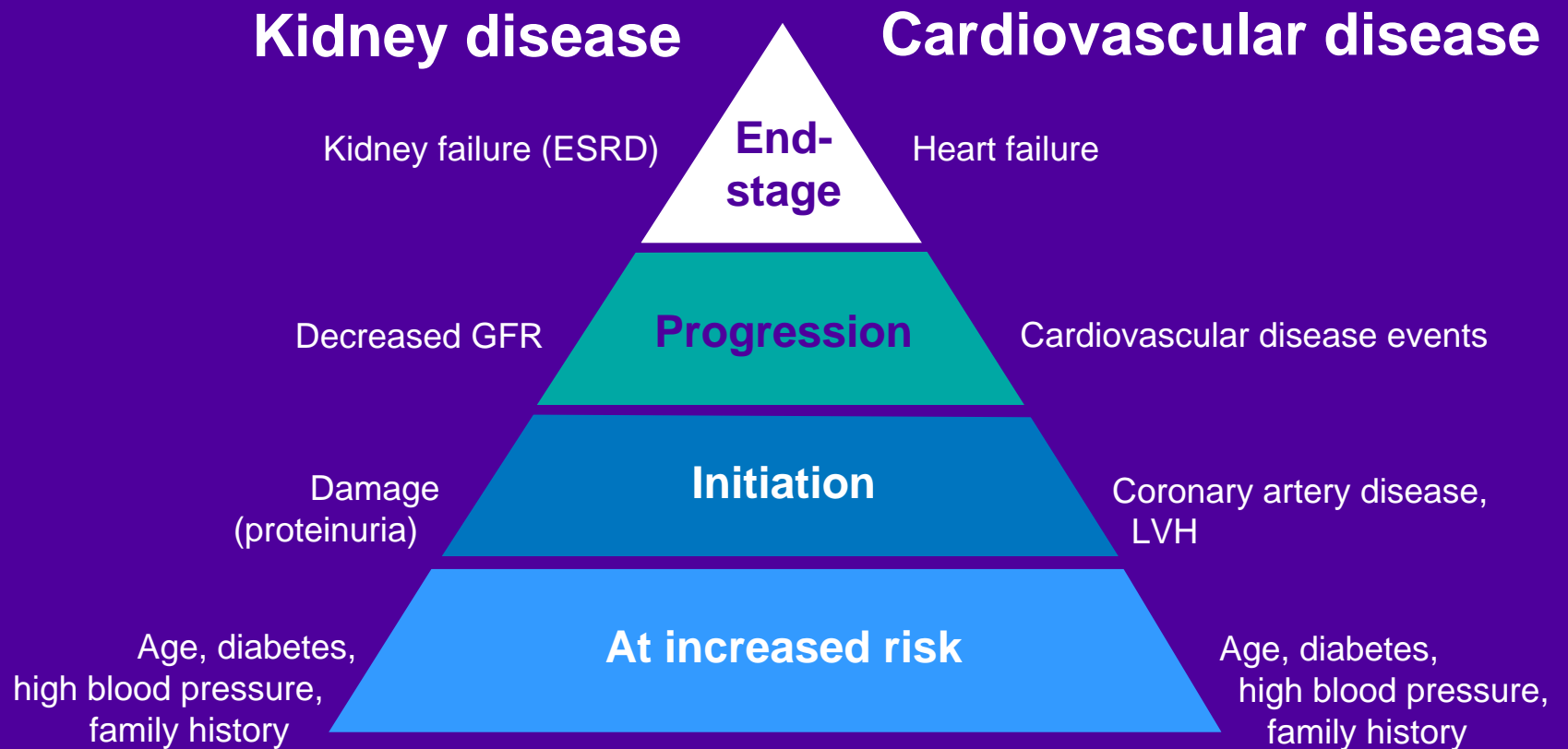


Goals of Early Treatment

- Preventing development of nephropathy
- Preventing progression of nephropathy to ESRD
- Preventing development of CV morbidity and mortality

ERDS=end stage renal disease
CV=cardiovascular

Stages of...



ERDS=end stage renal disease

GFR=glomerular filtration rate

LVH=left-ventricular hypertrophy

KDOQI. *Am J Kidney Dis* 2007.



Prevention of Nephropathy and ESRD

- BP control
- Glucose control
- Angiotensin blockade
- Control of dyslipidemia
- Protein restriction
- Control of anemia
- Patient education



Current Treatment Practices

Treatment group	Preferred agent
Type 1 diabetes	ACE inhibitor
Type 2 diabetes Creatinine clearance >60 mL/min Creatinine clearance ≤60 mL/min	ACE inhibitor/ARB ARB

- **Optimization of BP < 130/ 80 mmHg**

ACE=angiotensin-converting enzyme
ARB=angiotensin receptor blocker
BP=blood pressure



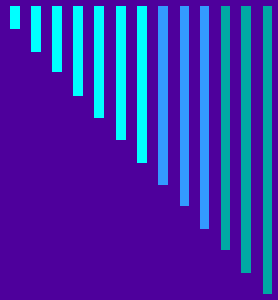
Current Treatment Practices

- Glycemic control
 - Hemoglobin A1c < 7%
 - Regular blood glucose monitoring
 - Diet and exercise
 - Management of dyslipidemia
 - LDL cholesterol < 2.5 mmol/L
 - Total cholesterol: HDL cholesterol < 4.0 mmol/L
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Current Treatment Practices

- Protein restriction in diet (MDRD)
 - Reduces glomerular hyperfiltration and decreases urinary albumin excretion.
 - Recommend 0.6g/ kg/ day slows rate of GFR decline 60 – 75%.
 - Anemia:
 - Cardinal feature of CKD.
 - Usually present when GFR reaches 30 – 40 ml/ min.
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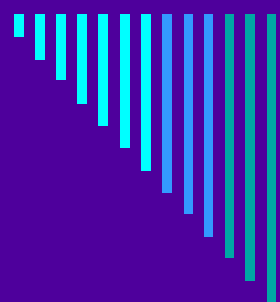
Current treatment Practices: Anemia

- Target hemoglobin values at 110 -120 g/L.
 - Ensure adequate iron stores
 - Monitor serum folate & B12 levels.
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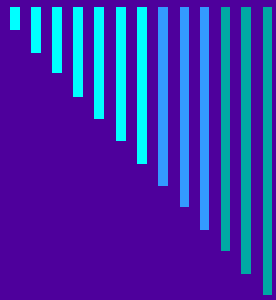
Current Treatment Practices

- Early referral to nephrologist
 - Serum creatinine 300 μ mol/L or CrCl < 30 ml/ min (CKD stages 4-5)
 - Optimal preparation for dialysis or transplantation requires one year.
 - Education & selection of treatment modality
 - Transplant work up
 - Creation of dialysis access
-



Current Treatment Practices: ESRD

- Hemodialysis in centre or at home
- Peritoneal dialysis
- Kidney or kidney pancreas transplant
- No renal replacement therapy



Current Treatment Practices: Hemodialysis

- Process of filtering the blood through a semi permeable membrane using the principles of osmosis, diffusion and ultrafiltration.
- In centre; 3 times per week
- 4 hour treatments
- Access required:
 - Permanent CVC
 - AV Fistula or graft
 - Temporary CVC



Current Treatment Practices: Peritoneal Dialysis

- Uses the peritoneum as the filter
 - Done 7 days per week
 - Modalities:
 - Continuous ambulatory peritoneal dialysis (CAPD)
 - Automated peritoneal dialysis (APD)
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Conclusions

- Diabetic nephropathy is the major cause of CKD
- The slow progression should allow early detection and treatment
- Blood pressure control and angiotensin II blockade are effective at slowing rate of progression



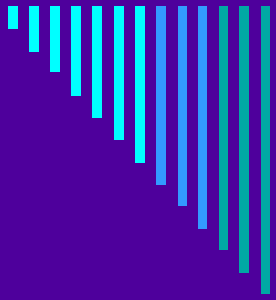
Conclusions

- Serum creatinine underestimates degree of CKD
- Calculated GFR can alert clinicians to presence and severity of CKD
- Anemia occurs earlier in diabetic nephropathy
 - Associated with cardiovascular damage
 - Detrimental effects begin long before dialysis is required



Reference List

- ❑ Cavanaugh, K.L. (2007). Diabetes management issues for patients with chronic kidney disease. *Clinical Diabetes*, 25(3): 90-97.
- ❑ Holcomb, S. (2004). Keeping kidney function flowing. *Nursing Made Incredibly Easy*. September/October : 30-41.
- ❑ Kallenbach, J.Z., Gutch, C.F., Stoner, M.H. & Corea, A.L. (2005). Chapter 18 Diabetes and hemodialysis: In *Review of Hemodialysis for Nurses and Dialysis Personnel*. 7th ed. Elsevier Mosby, St. Louis Missouri.
- ❑ Kausz, A. T. Chronic kidney disease in the older patient with diabetes. Downloaded from <http://www.clinicalgeriatrics.com/article/2040> on August 31, 2007.
- ❑ Ravenscroft, E.F. (2005). Diabetes and kidney failure: how individuals with diabetes experience kidney failure. *Nephrology Nursing Journal*. 32(4): 502-509.
- ❑ Russel, T.A (2006). Diabetic nephropathy in patients with type 1 diabetes mellitus. *Nephrology Nursing Journal*. 33(1): 15-29.
- ❑ www.kidney.org/professionals/kdoqi. Accessed on October 10, 2007.



Thank You

A decorative illustration featuring a green vine that curves around the text. On the left, there is a pink flower bud. On the right, there is a fully bloomed pink daisy with a yellow center. A green leaf is also visible near the base of the daisy.