MANITOBA NEPHROLOGY NURSING COURSE

Self-Learning Package
**Manitoba Nephrology Nursing Course**

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*This Self Learning Package has been created by the Manitoba Renal Program Renal Education Department.*
INTRODUCTION TO THE MANITOBA RENAL PROGRAM

The Manitoba Renal Program (MRP), established in October 1997, is one of the clinical programs within the Winnipeg Regional Health Authority (WRHA). The program operates through a Memorandum of Understanding with the Government of Manitoba, which indicates that under the auspices of the WRHA, the MRP is to oversee the management and delivery of kidney health services including hemodialysis, peritoneal dialysis, renal health clinics and renal health outreach in Manitoba. Manitoba is the only province in Canada that has a single provincial renal program, and all dialysis services are funded directly through the provincial program.

As of June 30, 2016 in Manitoba, there were 1557 people receiving dialysis services. 1208 were receiving in-centre hemodialysis services, while 281 patients received Peritoneal Dialysis and 68 were on Home Hemodialysis. Each year there is an average of 35-45 net new patients who begin a dialysis therapy. In addition to these patients, there are approximately 5200 patients who are followed by the Renal Health Clinics. The 2016 MRP annual budget to manage this care service was approximately $80 million.

Hemodialysis Services: Hemodialysis is offered in Winnipeg, Brandon, and sixteen rural locations throughout the province spanning over five Regional Health Authorities. Winnipeg hemodialysis sites include the Health Sciences Centre, St. Boniface Hospital and Seven Oaks Hospital and in Brandon at the Brandon Regional Health Center. The current rural hemodialysis locations are:

- Lakeshore General Hospital (Ashern, MB)
- Dauphin Health Centre (Dauphin, MB)
- Flin Flon General Hospital (Flin Flon, MB)
- Boundary Trails Health Complex (Morden, MB)
- Norway House Hospital (Norway House, MB)
- The Pas Health Complex (The Pas, MB)
- Portage General Hospital (Portage, MB)
- Pine Falls Health Complex (Pine Falls, MB)
- Selkirk General Hospital (Selkirk, MB)
- Swan River Valley Hospital (Swan River, MB)
- Thompson General Hospital (Thompson, MB)
- J.A. Hildes Northern Medical Unit (Island Lakes, MB)
- Berens River Renal Health Unit (Berens River, MB)
- Gimli Community Health Centre (Gimli, MB)
- Percy E. Moore Hospital (Hodgson, MB)
- Russell District Health Centre (Russell, MB)
**Peritoneal Dialysis Services:** Peritoneal dialysis training and follow-up care is currently offered at St. Boniface Hospital and Seven Oaks Hospital. Most patients are able to return to their home communities once they have learned their treatment regimen, as they usually self-manage their care. Those who are unable to manage in Winnipeg may be referred to the Peritoneal Dialysis Community Care (PDCC) and receive nursing support in the home.

**Home Hemodialysis Services:** Home Hemodialysis training and follow-up care is currently offered at Health Sciences Centre and Seven Oaks Hospital. Patients are taught to initiate and manage their own hemodialysis care. Adequate water supply and sewage capacity are needed.

**Renal Health Clinic Services:** Renal/Kidney Health Clinics focus on kidney health and disease prevention to delay the onset and progression of kidney disease; and to prepare for renal replacement therapy such as hemodialysis, peritoneal dialysis or transplant when disease progression cannot be stopped. In Manitoba, this service is currently operated through Health Sciences Centre (HSC), St. Boniface Hospital (SBH), Seven Oaks Hospital (SOH), Brandon Regional Health Centre (BRHC), as well as various rural centres.

**Renal Education Services:** Under the direction of the WRHA, the MRP provides the Manitoba Nephrology Nursing Course (MNNC) to nurses as they progress in their careers with the speciality of nephrology nursing. The Manitoba Local Centres Dialysis Units (MLCDU), HSC, SBGH, SOGH, and BRHC collaborate with the Renal Education Department to provide this education for nurses hired for individual units. On-going continuing educational events are also provided in various formats (MB Telehealth, Self-Learning Packages, MRP Conferences, Nursing Journal Club, PD Workshops, etc.).
THE RENAL EDUCATION DEPARTMENT

The Manitoba Renal Program, Renal Education Department wishes you well as you learn nephrology nursing. Our aim during the MNNC is to assist you in having a successful period of study.

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You may call instructors for assistance at any time. Should you reach a voice mailbox, please leave a message with your name, phone number and a time when you can be reached. The instructor will make every attempt to return your call within a 24-hour time period. Please do not hesitate to call.
PHILOSOPHY STATEMENT OF MANITOBA RENAL PROGRAM

EDUCATION PROGRAM

The Manitoba Nephrology Nursing Program Educational Team empowers and nurtures Health Care Providers to develop and maintain expertise in the care of people living with renal disease. We promote the delivery of compassionate and culturally sensitive care. We believe in providing high quality, innovative, and standardized education throughout Manitoba.

Learning is supported in a climate of mutual trust and respect. It is an active and personal process for the learner. Incorporating the principles of adult education, educators provide opportunities and activities that facilitate learning.

COURSE STRUCTURE AND DESIGN

To enter the MNNC program, you must be hired at an MRP site. Once you are hired, you must complete the MNNC Self Learning Package (SLP) and Pre-Entrance Exam. Alternately, you may complete the SLP and Pre-Entrance Exam prior to applying to facilities. Once hired and having written the exam you will take the MNNC during the next course offering before you begin working in a dialysis unit. The MNNC is offered several times throughout the year.
### MNNC Course Fee Structure

<table>
<thead>
<tr>
<th>Item</th>
<th>Fee</th>
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<tbody>
<tr>
<td>Self Learning Package</td>
<td>No Charge</td>
</tr>
<tr>
<td>Pre-Entrance Exam</td>
<td>No Charge</td>
</tr>
<tr>
<td>Tuition Fees (non-refundable)</td>
<td>$200.00</td>
</tr>
<tr>
<td>Informational Text Books</td>
<td>$254.95 (optional)</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$454.95</strong></td>
</tr>
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</table>

Your hiring facility will provide a stipend while you take the MNNC. Please contact your hiring facility for more information.

### The informational texts are:


Texts are available through the University of Manitoba Bookstore, Bannatyne Campus. [www.umanitoba.ca/bookstore](http://www.umanitoba.ca/bookstore) or 204-789-3601.
THE MNNC CONSISTS OF THREE COMPONENTS:

Self-Learning Package and Exam

Theory and Clinical Component

Perceptorship

Self-Learning Package and Exam:
The Self Learning Package provides baseline knowledge of Chronic Kidney Disease (CKD), the causes and complications of CKD and a review of the anatomy and physiology of the kidneys. The MNNC Pre-Entrance Exam will focus specifically on the materials covered in this Self Learning Package. A passing grade of 70% is required on the Pre-Entrance Exam and remains valid for one year. One rewrite opportunity will be provided, with a passing grade of 85%. The exam is administered at a MRP dialysis site through the MRP Regional Educators and the manager of the hiring dialysis unit. You are not required to have a MRP dialysis nurse position prior to writing the MNNC Pre-Entrance Examination. To schedule an exam, call (204) 787-3317 or email: mrp.ed@hsc.mb.ca.
Theory and Clinical Component:

The theory and clinical component takes place in Winnipeg or Brandon and consists of 6 weeks of combined classroom and clinical study. To enter into this component, the nurse must be hired by a MRP dialysis site; the dialysis site manager will arrange for course admission and renumberation for the duration of the course. The theory classes are provided at the Health Sciences Centre or Brandon Regional Health Centre and build upon the Self Learning Package. In this section one can expect to learn more advanced aspects of renal replacement therapies, with a focus on holistic care of the hemodialysis patient.

Clinical experiences are available at HSC, SOH, SBH and BRHC. Every effort will be made to accommodate clinical site requests, but attending the site of your choice cannot be guaranteed.

Perceptorship:

The preceptorship component requires 120 hours of clinical practice under the guidance of an experienced nephrology nurse preceptor. You will follow your preceptor’s shift schedule during this time.

The successful completion of the above MNNC requirements entitles you to practice as a novice renal nurse in the position you obtained prior to starting the MNNC program.
ACRONYMS AND ABBREVIATIONS

This list represents commonly used abbreviations and acronyms in the speciality of nephrology nursing. *(These are not necessarily hospital approved)*

ACE .......................................................... Angiotensin Converting Enzyme
ANNA ..........................................................American Nephrology Nursing Association
APD ............................................................Automated Peritoneal Dialysis
ARF ............................................................. Acute Renal Failure
ATN ............................................................. Acute tubular necrosis
AV ..............................................................Arteriovenous
AVG ............................................................. Arteriovenous Graft
AVF ............................................................. Arteriovenous Fistula
BG .............................................................. Blood Glucose
BS .............................................................. Blood Sugar
BUN ............................................................. Blood Urea Nitrogen
BVM ............................................................. Blood Volume Monitor
CAD ............................................................. Coronary Artery Disease
CANNT ........ Canadian Association of Nephrology Nurses & Technicians
CAPD .......................................................... Continuous Ambulatory Peritoneal Dialysis
CCPD .......................................................... Continuous Cycling Peritoneal Dialysis
CQI ............................................................. Continuous Quality Improvement
CKD ............................................................. Chronic Kidney Disease
Cr ............................................................... Creatinine
CrCl ............................................................ Creatinine Clearance
CKF ............................................................. Chronic Kidney Failure
CRRT ........................................ Continuos Renal Replacement Therapy
CVAD ........................................ Central Venous Access Device
CVC ................................. Central Venous Catheter
DDS ........................................ Dialysis Disequilibrium Syndrome
DM ........................................ Diabetes Mellitus
CDU ........................................ Central Dialysis Unit (A6/B6)
DW ........................................ Dry Weight
ECF ........................................ Extracellular Fluid
EDW ........................................ Estimated Dry Weight
eGFR ........................................ estimated Glomerular Filtration Rate
ePTFE ........................................ expanded Polytetrafluoroethylene
ESRD ........................................ End Stage Renal Disease
EPO ........................................ Erythropoetin
GFR ........................................ Glomerular Filtration Rate
GN ........................................ Glomerulonephritis
HBV ........................................ High Biological Value
Hct ........................................ Hematocrit
HF ........................................ Heparin Free
HD ........................................ Hemodialysis
Hgb ........................................ Hemoglobin
Hg ........................................ Mercury
HTN ........................................ Hypertension
ICF ........................................ Intracellular Fluid
IgA ........................................ Immunoglobulin A
IP ........................................ Intraperitoneal (medication)
K ........................................ Potassium
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>KDOQI</td>
<td>Kidney Disease Outcomes Quality Initiative</td>
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<tr>
<td>Kecn</td>
<td>Clearance, effective conductivity for Na</td>
</tr>
<tr>
<td>Kt/V</td>
<td>Clearance over time, Urea volume</td>
</tr>
<tr>
<td>Kuf</td>
<td>Ultrafiltration Coefficient</td>
</tr>
<tr>
<td>LVH</td>
<td>Left Ventricular Hypertrophy</td>
</tr>
<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
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<tr>
<td>MRP</td>
<td>Manitoba Renal Program</td>
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<tr>
<td>MNNC</td>
<td>Manitoba Nephrology Nursing Course</td>
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<tr>
<td>NKF KDOQI</td>
<td>National Kidney Foundation Kidney Disease Outcomes Quality Initiative</td>
</tr>
<tr>
<td>NSAID</td>
<td>Nonsteroidal Anti-inflammatory Drug</td>
</tr>
<tr>
<td>NIDDM</td>
<td>Non-insulin Dependent Diabetes Mellitus</td>
</tr>
<tr>
<td>PCR</td>
<td>Protein Catabolic Rate</td>
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<tr>
<td>PD</td>
<td>Peritoneal Dialysis</td>
</tr>
<tr>
<td>PDCC</td>
<td>Peritoneal Dialysis Community Care</td>
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<tr>
<td>PKD</td>
<td>Polycystic Kidney Disease</td>
</tr>
<tr>
<td>PTFE</td>
<td>Polytetrafluoroethylene</td>
</tr>
<tr>
<td>PTH</td>
<td>Parathyroid Hormone</td>
</tr>
<tr>
<td>PUR</td>
<td>Percentage of Urea Reduction</td>
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<td>PVD</td>
<td>Peripheral Vascular Disease</td>
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<tr>
<td>Qa</td>
<td>Access Flow Rate</td>
</tr>
<tr>
<td>Qb</td>
<td>Blood Pump Flow Rate</td>
</tr>
<tr>
<td>Qd</td>
<td>Dialysate Flow Rate</td>
</tr>
<tr>
<td>OLC</td>
<td>Online Clearance</td>
</tr>
<tr>
<td>repo</td>
<td>Recombinant human Erythropoetin</td>
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<tr>
<td>RHC</td>
<td>Renal Health Clinic</td>
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</table>
RHO......................................................................................................... Renal Health Outreach
RO ........................................................................................................... Reverse Osmosis
RRT .......................................................... Renal Replacement Therapy
SCDU ........................................................ Sherbrook Centre Dialysis Unit
SP ........................................................ Single Pool (refers to Kt/V measurement)
TBW ............................................................ Total Body Water
TCD .......................................................... Theoretical Conductivity of Dialysate
TMP .......................................................... Transmembrane Pressure
UFR ................................................................................................... Ultrafiltration Rate
URR ................................................................................................ Urea Reduction Ratio
V ......................................................................................................... Urea distribution Volume
WRHA ....................................................... Winnipeg Regional Health Authority
WEB ADDRESSES

American Nephrology Nurses Association:
http://www.annanurse.org/cgi-bin/WebObjects/ANNANurse

Canadian Association of Nephrology Nurses & Technologists:
http://www.cannt.ca/

Canadian Society of Nephrology:
http://www.csnscn.ca/english/home/default.asp?s=1

European Dialysis and Transplant Nurses Association/European Renal Care Association:
http://www.edtna.org/

Manitoba Renal Program:
http://www.kidneyhealth.ca/

National Kidney Foundation:
http://www.kidney.org/

RECOMMENDED NEPHROLOGY JOURNALS

American Journal of Nephrology

Canadian Association of Nephrology Nurses and Techs Journal

Journal of Nephrology

Kidney International

Nephrology, Dialysis, Transplantation

Nephrology Nursing Journal
MANITOBA NEPHROLOGY NURSING COURSE SELF-LEARNING PACKAGE OBJECTIVES

INTRODUCTION:

THE NURSE WILL BE ABLE TO:

1. State the regulatory bodies that guide nephrology practice.
   a. International
   b. Canadian

NORMAL KIDNEY FUNCTION

THE NURSE WILL BE ABLE TO:

1. Describe the location of the kidneys.
2. State the average size of each kidney.
3. State the five key functions of the kidneys.
4. Describe how many liters of blood are sifted by the kidneys each day.
5. State how the kidneys accomplish fluid and electrolyte balance.
6. State how the kidneys achieve acid base balance.
7. State three hormonal functions that the kidney is involved in.
MEASURING KIDNEY FUNCTION

THE NURSE WILL BE ABLE TO:

1. State the two terms most often used in describing kidney function.
2. Describe a creatinine clearance test.
3. State the normal creatinine clearance rate.
4. Describe glomerular filtration rate (GFR).
5. State the normal GFR.

RENAL ANATOMY AND PHYSIOLOGY

THE NURSE WILL BE ABLE TO:

1. Label the following macro-anatomy on a diagram of the kidney and give a brief description of each:
   a. Hilum
   b. Renal Artery
   c. Renal Vein
   d. Renal Capsule
   e. Cortex
   f. Medulla
   g. Pyramids
   h. Papilla
   i. Calyces/Calyx
   j. Renal Pelvis
   k. Ureters
RENAL CIRCULATION

THE NURSE WILL BE ABLE TO:

1. State how much cardiac output the kidneys receive.
2. State two unique traits of the kidneys shared by no other part of the human body.
3. Describe the pathway of renal circulation from the aorta to the inferior vena cava.

THE NEPHRON

THE NURSE WILL BE ABLE TO:

1. State how many nephrons are present in normal healthy kidneys.
2. Locate on a diagram and give a brief description of the function of the following structures:
   1. Glomerulus
   2. Bowman’s Capsule
   3. Proximal Convoluted Tubule
   4. Loop of Henle
   5. Distal Convoluted Tubule
   6. Collecting Duct
3. State what glomerular filtrate is.
4. Describe the final process of urine production as the glomerular filtrate leaves the kidney.
CAUSES OF CHRONIC KIDNEY DISEASE

THE NURSE WILL BE ABLE TO:

1. The nurse will be able to describe how each of the following causes of kidney disease harms the kidneys:
   a. Diabetes Mellitus
   b. Hypertension
   c. Glomerulonephritis
      i. IgA Nephropathy
      ii. Goodpasture’s Syndrome
      iii. Post-infectious Glomerulonephritis
   d. Autosomal Dominant Polycystic Kidney Disease
   e. Systemic Lupus Erythematos
   f. Systemic Vasculitis
      i. Wegner’s Granulomatosis
      ii. Henoch-Schonlein Purpura
   g. Thrombotic Microangiopathy: Hemolytic Uremic Syndrome (HUS)
   h. Multiple Myeloma
   i. Amyloidosis
   j. Progressive Systemic Sclerosis: Scleroderma
   k. Urinary Tract Infections: Pyelonephritis
   l. Chronic Drug Induced Tubulointerstitial Nephritis (TIN)
   m. Renal Artery Stenosis
   n. Alport’s Syndrome
CHRONIC KIDNEY DISEASE (CKD)

The nurse will be able to:

1. Define chronic kidney disease including the markers of damage.
2. List 6 risk factors for CKD.
3. List the Stages of Kidney Disease and the therapeutic focus of each stage.
4. Discuss the following complications of kidney disease:
   a. Cardiovascular disease
   b. Hypertension
   c. Anemia
   d. Protein-energy Malnutrition
   e. Metabolic Acidosis
   f. Disturbances in mineral and bone metabolism
   g. Neurological disturbances
   h. Dyslipidemia
   i. Quality of life
   j. Pregnancy and pre-existing renal disease

ACUTE KIDNEY INJURY (AKI)

The nurse will be able to:

1. Define acute kidney injury.
2. State by what percentage the GFR may decrease.
3. Describe the clinical symptoms of AKI.
4. State the overall mortality rates.
5. State the three main types of AKI and where/how the kidney damage occurs.
6. State the most common causes of pre-renal failure.
7. State the most common causes of intra-renal failure.
8. State the most common causes of post-renal failure.
**CKD in Manitoba**

*The Nurse Will Be Able To:*

1. Discuss ESRD incidence/prevalence in Manitoba and Canada.
2. Describe approximate numbers of people on hemodialysis, peritoneal dialysis, Home Hemodialysis, and followed through renal health clinics in Manitoba.
INTRODUCTION:

The field of medicine that studies kidneys and their diseases are called nephrology. “Nephro” is from an ancient Greek word meaning kidney, while “renal” comes from Latin.

There are international standards that guide professionals in the care of the patient with kidney disease. The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI™) or KDOQI™ provides evidence-based clinical practice guidelines for all stages of chronic kidney disease and related complications. To view these standards, please visit http://www.kidney.org/professionals/KDOQI/.

There are also specific Canadian guidelines through the Society of Nephrology (CSN). The CSN is a society of physicians and scientists specializing in the care of people with kidney disease and in research related to the kidney and kidney disease. To view this website, please visit: www.csnscn.ca.

As well there is an association for renal nurses and technologists called the Canadian Association for Nephrology Nurses and Technologists (CANNT). CANNT’s goal is to promote the dissemination of knowledge amongst those involved in the care of patients with renal disease. They also publish Nephrology Nursing Standards and Practice Recommendations. To view this information, please visit: www.cannt.ca.
NORMAL KIDNEY FUNCTION

SUPPLEMENTAL READING
CH 4, CONTEMPORARY NEPHROLOGY NURSING
CH 1, CORE CURRICULUM FOR NEPHROLOGY NURSING

The kidneys are two essential, bean-shaped organs, each about the size of an average fist. They are located in the flank regions on either side of the spine. The kidneys perform several key functions.

1. **Removal of waste products**
   The kidneys process 1200ml of blood per minute to sift out 1000-3000ml of waste product and water (called urine) each day. The waste is generated from end products of food digestion, body metabolism, and environmental factors such as drugs and water-soluble toxins. Waste products include substances such as urea, creatinine, and uric acid.

2. **Body fluids and electrolytes balance**
   Healthy kidneys excrete and resorb varying amounts of water and other substances such as potassium, chloride, sodium, and phosphorus. The amount of urine produced is regulated primarily by antidiuretic hormone (ADH) and by aldosterone. These hormones help the kidney regulate the total volume of extracellular fluids, the concentration of the urine (water, solutes) and the specific quantity of different electrolytes such as sodium, potassium, and chloride resorbed or excreted.

   *ADH* is produced by the hypothalamus and secreted by the posterior pituitary gland and signals the kidneys to either concentrate or dilute urine.

REMEMBER:

1. When ADH increases (↑), urine secretion will decrease (↓).
2. When extracellular fluid volume ↓, the kidneys retain fluid.

5 MAIN FUNCTIONS OF THE KIDNEYS:

1. Removal of waste products
2. Balance electrolytes & fluids
3. Balance pH
4. Hormonal & Enzymatic functions
5. Blood Pressure control
Aldosterone is produced by the adrenal cortex and regulates the volume of blood and extracellular fluid primarily by the reabsorption of sodium (Na) by the kidneys.

When the extracellular fluid volume is increased, the blood volume is also increased causing increased venous return to the heart and subsequent increase in cardiac output. The increase in cardiac output results in increased arterial pressure which causes the kidneys to excrete excess fluid. If the kidneys are unable to excrete excess fluid due to underlying disease processes, the interstitial spaces are forced to expand to accommodate the extra fluid. Excess fluid in the interstitial spaces is called edema.

If the extracellular fluid volume is decreased due to increased loss or inadequate intake, the kidneys respond by retaining more fluid. If the fluid volume deficit is too great, the kidney may not be able to compensate for the imbalance and other treatment (such as IV fluid) may become necessary.

3. Acid-base balance

The kidneys are considered the most powerful regulator of acid/base balance in the body and can excrete varying amounts of acid or base. Renal insufficiency or failure can cause metabolic acidosis.

Normal body fluid pH is between 7.35 and 7.45. If the pH is too high (a state called alkalosis), the kidney will increase the excretion of bicarbonate (base) and increases reabsorption of hydrogen ions (acid). If the body pH is low (called acidosis), the kidney will decrease the excretion of bicarbonate and decrease the absorption of hydrogen ions.
4. **Hormonal and Enzymatic functions**

The kidneys have a critical role in the activation of *Vitamin D* for maintaining the calcium-phosphate balance. It plays an important role in increasing calcium absorption from the intestinal tract, and in the deposition and reabsorption (formation) of bone.

*Erythropoietin (EPO)* is secreted by the kidney in response to low hemoglobin (anemia). Kidneys produce 90% of EPO. This hormone stimulates the bone marrow to make red blood cells.

*Renin* is an enzyme that helps to control blood pressure. The kidney releases renin when the blood pressure is low and causes the blood vessels to constrict and thus increase the blood pressure.

These 4 essential functions decline in diseased kidneys. However, with early management by a team of Renal Health Professionals, this decline can often be slowed dramatically.

5. **Blood Pressure (BP) Control**

The kidneys play a dominant role in long term maintenance of arterial blood pressure. When extracellular fluid increases arterial blood pressure increase, this triggers the kidneys to excrete extra fluid to return pressure to normal.

Mechanisms utilized by the kidneys:

1. Renin-Angiotensin System (RAS) is a key mechanism kidneys use to regulate BP.
2. Aldosterone produced by the adrenal gland help maintain BP through producing exchange transport of Na+ and K+.
3. Antidiuretic Hormone regulates concentration of urine.

These 5 essential functions decline in diseased kidneys. However, with early management by a team of Renal Health Professionals, this decline can often be slowed dramatically.
Review:

1. The kidneys filter out ________________ litres of waste products and water daily called ________________.

2. Urea, uric acid and ________________ are substances in the waste products.

3. Potassium, ________________ sodium and ________________ are substances the kidneys excrete and ________________.

4. The waste product, ________________ is regulated by two hormones: ________________ and ________________.

5. These two hormones regulate:
   1. the total volume of ________________
   2. the ________________ of urine
   3. the specific amount of ________________ such as sodium, potassium and chloride

6. What are the 5 main functions of kidneys?
   1. ________________
   2. ________________
   3. ________________
   4. ________________
   5. ________________

7. Urine contains waste products such as:
   1. ________________
   2. ________________
   3. ________________

8. The two hormones that regulate the amount of urine are ________________ and ________________.

9. ADH stands for ________________.

10. ADH results in retention/excretion of water.
11. Aldosterone regulates the volume of blood and ________________, mainly through the reabsorption of ________________.

12. Do the kidneys help regulate pH in the body?  Yes/No

13. Bicarbonate is a(n) acid/base, hydrogen ions are acidic/basic.

14. When the pH is too high it is acidosis/alkalosis, the kidneys excrete more __________ and increase absorption of ________________.

15. When extracellular volume increases, blood volume increases/decreases which increases/decreases cardiac output.

16. Increased cardiac output increases/decreases arterial pressure which causes the kidneys to increase/decrease excretion.

17. If kidneys are unable to excrete fluid due to disease, this causes the extracellular spaces to expand/contract to accommodate the extra fluid.

18. Why is the conversion of Vitamin D important in the body?
   1. 
   2. 
   3. 

19. What is one effect of Erythropoietin not being secreted by the kidneys? ____________________
**Measuring Kidney Function**

**Supplemental Reading**

*CH 8, Contemporary Nephrology Nursing*

*CH 1, Core Curriculum for Nephrology Nursing*

Kidney function is most often expressed in terms of *creatinine clearance* (CrCl) or *glomerular filtration rate* (GFR). The creatinine clearance test compares the level of creatinine in urine with the creatinine level in the blood, usually based on measurements of a 24-hour urine sample and a blood sample drawn at the end of the 24-hour period. Clearance is often measured as millilitres/minute (ml/min). Normal creatinine clearance for adults is 75-125 ml/min/1.73m².

eGFR is the standard by which kidney function is assessed. Creatinine clearance is used to calculate the eGFR because creatinine is:

- found in stable plasma concentrations,
- freely filtered and not reabsorbed
- minimally secreted by the kidneys.

**Review:**

1. Creatinine clearance test compares the level of _______ in urine with the creatinine level in ____________________.

2. Normal creatinine clearance is _______ ml/______/1.73m²

3. True or False:
   - ______ Creatinine is extensively secreted by the kidneys.
   - ______ Creatinine is easily reabsorbed.
   - ______ Creatinine is found in stable plasma concentrations.
   - ______ Creatinine is not freely filtered.

**Remember**

**Normal GFR For Adults is 125 ml/min**
Macro anatomy of the kidney:

Copyright Amgen Canada Inc., 2007/8. This diagram has been included on this document to support nursing education with permission from Amgen Canada Inc.
Hilum is where the renal blood vessels, lymphatics, nerves and the ureters enter or exit the kidney.

Renal artery is the main artery that carries blood into the kidney.

Renal vein is the main vein that carries blood away from the kidney.

Capsule or renal capsule is a fibrous layer covering the kidney.

Cortex is the outer layer of the kidney and is underneath the capsule. The cortex contains ~80-85% of the nephrons (cortical nephrons) and their blood vessels.

Medulla is the inner portion of the kidney. It consists of pie-shaped wedges called pyramids. The papilla, the point of the ‘pie’ of the pyramids, projects into the calyx.

There are two types of calyces – minor and major.

- Urine travels from the papilla into a minor calyx
- Several minor calyces will form a major calyx and urine will move from here to the renal pelvis.

Renal pelvis is the inner portion of the kidney where the major calyces meet to empty the urine.

The ureter exits the renal pelvis and transports urine to the bladder.
Review:

Fill in the blanks or circle the correct responses:

1. The _________ is where the renal blood vessels, lymphatic, nerves and the ureters enter or exit the kidney.
2. The renal artery is the main artery that carries blood into/out the kidney.
3. The renal vein is the main vein that carries ________ away from the kidney.
4. The ___________ is a fibrous layer covering the kidney.
5. The cortex contains ________ of the nephrons (cortical nephrons) and their blood vessels.
6. The medulla is the inner/outer portion of the kidney. It consists of pie-shaped wedges called__________.
7. The papilla, the point of the ‘pie’ of the pyramids, projects into/away from the calyx.
8. There are two types of calyces __________ and ________. Urine travels from the papilla into a ________calyx.
9. Several minor calyces will form a ________calyx and urine will move from here to the __________.
10. The ureter exits the renal pelvis and transports urine to the ____________.

1. Hilum,  2. into,  3. blood,  4. renal capsule,  5. 80-85%,  6. inner, pyramids  7. into,  8. minor major, minor  9. major renal pelvis,  10. bladder
REMEMBER:

1. Afferent arteriole → glomerular capillaries → efferent arteriole is the only place in the body where capillaries join to arteries.
2. The two sets of capillary beds in one system

RENAL CIRCULATION

The kidneys receive 25% of the body’s total cardiac output and therefore are vascular organs. The kidney has two unique traits shared by no other part of the human body:

1. The only place in the body where capillaries are joined by two arteries and,
2. Having two sets of capillary beds in each circulation loop.

Copyright, Amgen Canada Inc., 2007/8. This diagram has been included on this document to support nursing education with permission from Amgen Canada Inc.
Oxygenated blood leaves the heart via the *aorta* and branches off at the *renal artery* to enter the kidney at the hilum.

From the renal artery, the renal circulatory system branches into the *interlobar arteries* that travel alongside the pyramids into the cortex.

The oxygenated blood enters the *arcuate arteries* branch into *interlobular arteries* which travel further into the cortex.

Interlobular arteries then divide into *afferent arterioles*.

The afferent arterioles supply the *glomerulus* (glomerular capillaries) where glomerular filtration occurs.

The blood and remaining fluid in the glomerular capillaries rejoin into the *efferent arterioles*.

Efferent arterioles branch off with one branch leading to the *peritubular capillary network*, which provides an extensive blood supply to the cortex of the kidney and the second branch forms the *vasa recta*.

Now that the blood has been filtered and has nourished the kidney, the *interlobular veins* empty into the *rein vein* that exits through the hilum and joins inferior *vena cava* which returns blood to the heart.
Review:

1. InterloBAR,
2. arcuate,
3. interlobular
4. efferent,
5. recta

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THE NEPHRON

SUPPLEMENTAL READING

CH 4, CONTEMPORARY NEPHROLOGY NURSING
CH 1, CORE CURRICULUM FOR NEPHROLOGY NURSING

The nephron is the powerhouse of the kidney. Its primary functions include the filtration of the blood, reabsorption of substances and the concentration and dilution of urine. There are approximately 1-1.5 million nephrons in each normal healthy kidney.

Filtration occurs in the glomerular capillary located within the glomerulus which is surrounded by Bowman’s capsule.

The pressure created by the heart forces water, electrolytes, urea, creatinine, uric acid, glucose and other substances through tiny filtration slits inside of these small glomerular capillaries.

This collection of filtrated substances is called glomerular filtrate. The glomerular filtration rate is 125ml/min, which will give approximately 180 litres of glomerular filtrate each day!

The glomerular filtrate collects in Bowman’s capsule or Bowman’s space.

The glomerular filtrate flows from the Bowman’s capsule to the proximal convoluted tubule. The proximal convoluted tubules lie in the cortex of the kidney and its primary function is re-absorption.

In the proximal convoluted tubule, approximately 2/3 of the glomerular filtrate is reabsorbed into the bloodstream such as plasma, water, nutrients and electrolytes are also reabsorbed.
REMEMBER
Filtration occurs in the glomerulus

REMEMBER
Glomerular filtrate is collected in Bowman’s capsule
The long, hairpin loop after the proximal tubule is called the **loop of Henle**. The loop of Henle consists of **descending** and **ascending** limbs. The loops of Henle extend from the cortex down into the medulla and back, and are responsible for reabsorbing electrolytes and water from the filtrate.

The **distal convoluted tubule** is situated between the loop of Henle and the collecting ducts located in the cortex of the kidney. It is partly responsible for the regulation of pH, potassium, sodium and calcium.

The **collecting duct** is the last portion of the nephron structure. A number of convoluted tubules join together to create the collecting ducts. The collecting ducts begin in the cortex and extend through the medulla and empty into the papilla. When ADH (antidiuretic hormone) is present water absorption occurs in the collecting ducts; in the absence of ADH, little water absorption occurs.

Once the glomerular filtrate has passed through the entire nephron portion, the remaining filtrate, now called **urine**, will pass through the minor then major calyces, into the renal pelvis and finally out the ureters.

Each day, there is approximately 1000-3000 ml of urine produced from the 180 Liters of glomerular filtrate that started the process.

Substances found in urine include urea, creatinine and uric acid, drugs and electrolytes (sodium, potassium and phosphate, etc.). (Refer to Section 2 if required.)
Review:

Fill in the blanks or circle the correct responses:

1. The normal GFR in healthy adult is: __________.

2. Filtration occurs in the __________ that is located in ________________.

3. The primary function of the proximal convoluted tubule is: re-absorption/excretion.

4. In the proximal convoluted tubule, approximately 2/3 of the glomerular filtrate is reabsorbed into the bloodstream such as ____________; ____________, ____________, & ____________ are also reabsorbed.

5. The loop of Henle consists of __________ & __________ and is responsible for reabsorbing/excreting electrolytes and small amounts of plasma water.

6. The distal convoluted tubule is situated between the loop of Henle and the collecting ducts located in ____________ of the kidney.

7. If ADH, also known as ________________________________ is present in the collecting ducts then water is ____________.

8. Substances found in urine include __________, __________, __________ & electrolytes.

1. 125ml/minute,
2. glomerulus, Bowman’s capsule,
3. re-absorption,
4. plasma, water, nutrients, & electrolytes,
5. ascending & descending reabsorb.
6. Cortex,
7. antidiuretic hormone, absorbed,
8. urea, creatinine, uric acid.
CAUSES OF CHRONIC KIDNEY DISEASE (CKD)

SUPPLEMENTAL READING:
CH 6 & CH 7, CONTEMPORARY NEPHROLOGY NURSING
CH 2 & CH 5, CORE CURRICULUM FOR NEPHROLOGY NURSING 5TH ED.

Diabetes Mellitus

It is the most common cause of kidney disease. Diabetic nephropathy is a long term complication of Diabetes Mellitus that occurs when the small capillaries of the glomerulus are damaged from prolonged poor blood sugar control and hypertension. The glomerulus thickens resulting in glomerulosclerosis, which is scarring or hardening of the blood vessels in the kidney that cause disturbances in the filtering process, allowing protein to leak from the blood into urine. This results in microalbuminuria (protein in urine) as the amount of albumin increases in the urine, the GFR decreases with resulting decline in kidney function. Individuals with both Type I and Type II DM may develop CKD, the risk increasing with the length of time a person has diabetes, hypertension and microalbuminuria.

Hypertension

Is the second leading cause of CKD in individuals without diabetes. Prolonged hypertension can cause nephrosclerosis, a term that refers to “hardening of the kidney.” Untreated hypertension can lead to renal artery stenosis, which decreases the blood supply to the nephrons. Clinical presentation is typically long-term essential hypertension and progressive renal insufficiency with mild proteinuria, retinal changes, and left ventricular hypertrophy.

Patients with diabetes mellitus or with evidence of renal damage should have their blood pressure controlled to less than 130/80 mmHg.
**Glomerulonephritis**

It is the third leading cause of CKD. *Glomerulonephritis* (GN) refers to a complex group of disease processes affecting the glomerulus. GN is an inflammation of the glomerulus leading to impairment of renal function partly due to the formation of antibody/antigen complexes. These become deposited within the glomerulus. Patients with glomerular diseases present with abnormalities in the urine, such as proteinuria, due to damage to the filtering membrane, edema and hypertension. A renal biopsy is required for a definitive diagnosis as well as to establish chronicity or reversibility. There are three common types of glomerulonephritis.

- **IgA nephropathy** is the most common form of GN worldwide. It is a condition in which there is an accumulation of IgA complexes within the glomeruli resulting in hematuria, proteinuria, and peripheral edema. The cause of IgA nephropathy is not known. However, it is felt that genetic factors may contribute.

- **Goodpasture’s syndrome (GPS)** is a disorder in which the body develops an autoimmune response to the glomerular basement membranes. Permanent and complete loss of renal function can occur in days to weeks.

- **Postinfectious Glomerulonephritis (PIGN)** can occur after a beta-hemolytic streptococcal infection of either the throat or of the skin. The streptococcal infection causes inflammation of the small blood vessels of the glomerulus. Signs include hematuria, mild proteinuria and oliguria. PIGN is rare before age 2, occurs primarily in school aged children, and can occur at any age in adults. There is usually a 7-14 day latent period after a throat infection and 14-28 days after a skin infection. Children and adults with no pre-existing kidney disease often respond fully to medical management.

**REMEMBER**

**THREE LEADING CAUSES OF CKD**

1. **Diabetes**
2. **Hypertension**
3. **Glomerulonephritis**
Review:

1. A complication resulting from diabetes mellitus is __________________________ which affects the kidneys eventually causing __________________________.

2. Glomerulosclerosis is __________________________.

3. __________________________” hardening of the kidney” is a complication affecting the kidneys that results from hypertension.

4. People with “hardening of the kidney”, present with the following:
   1. __________________________
   2. __________________________
   3. __________________________
   4. __________________________

5. There are ____________ main types of glomerulonephritis which is diagnosed through a renal __________________________.

6. GN is an inflammation of the glomerulus leading to an impairment of renal function partly due to the formation of __________________________ complexes.

7. Patients with glomerular diseases present with abnormalities in the __________________________, such as proteinuria.

8. The most common type of glomerulonephritis is called __________________________.

9. __________________________ is when the body develops an autoimmune response to the glomerular basement membrane.

10. Children often fully recover from __________________________, which occurs after an __________________________ infection of the throat or the skin.

   1. Diabetic nephropathy, glomerulosclerosis.
   2. Scarring/hardening of the blood vessels.
   4. Long-term essential hypertension, progressive renal insufficiency with mild proteinuria, retinal changes, and left ventricular hypertrophy.
   5. Three, biopsy.
   6. antibodies/antigens.
   7. Urine.
   8. Iga nephropathy.
   9. Good pasture’s syndrome (GPS)
   10. Post infectious glomerulonephritis (PIGN) streptococcal.
CAUSES OF CHRONIC KIDNEY DISEASE (CKD) CONTINUED:

Autosomal Dominant Polycystic Kidney Disease (ADPKD)

ADPKD is the most common inherited kidney disease. Normal kidney tissue is replaced with grape-like clusters that compress and destroy the surrounding tissue. ADPKD affects both men and women equally. Most common symptoms include pain in the back and sides (between ribs and hips) and headaches. Complications include hypertension, painful rupture of cysts, hemorrhagic cysts, hematuria, urinary tract infections, polyuria and nephrolithiasis. Treatment goals include management of hypertension and prevention of infection. About 50% of people with ADPKD develop end-stage renal disease (ESRD).

Systemic Lupus Erythematosus (SLE)

SLE is a chronic systemic inflammatory disorder of the connective tissues resulting from the formation of auto antibodies. It occurs more frequently in females. Renal involvement is referred to as Lupus Nephritis and is clinically present in 40% of patients at the time of diagnosis. Immune complexes are deposited in the glomerular capillaries and an inflammatory response follows. This in turn causes damage to the capillaries and adjacent structures. Specific signs and symptoms include malar or butterfly rash on face, photosensitivity, fever, arthralgia, elevated ESR, proteinuria, hematuria, and hypertension.
**Systemic Vasculitis**

Systemic vasculitis is characterized by inflammation of the blood vessels. Virtually any size or type of blood vessel in any organ can be affected. The following briefly discusses two types of vasculitis.

1. **Wegner’s Granulomatosis** is associated with positive antineutrophil cytoplasmic antibodies (ANCA). It predominantly affects the small and medium sized arteries of the kidneys and respiratory tract. Rapidly progressive glomerulonephritis is common in this disease. The exact cause is not known.

2. **Henoch-Schonlein Purpura (HSP)** is a type of vasculitis/inflammation involving the small vessels in the joints, skin, kidneys, and GI tract. It is most often seen in young children with a slightly higher incidence in males. The exact etiology is unclear; however, incidence increases in the winter and spring when upper respiratory tracts infections are more common.

**Thrombotic Microangiopathy: Hemolytic Uremic Syndrome (HUS)**

This a disease characterized by microangiopathic hemolytic anemia, thrombocytopenia, and various renal and neurological manifestations. Acquired Hemolytic Uremia Syndrome (HUS) is included in this disease category. HUS (also known as Hamburger disease) is most often caused by a strain of bacteria known as E. coli 0157:H7. In HUS, red blood cells are destroyed and platelet and fibrin thrombi occlude the glomerular capillaries and arterioles causing ischemia and infarction.
Review:

1. ADPKD which stands for _________________________________. It is the most common inherited kidney disease and about _____% of people with ADPKD will develop End Stage Renal Disease.

2. SLE( ________________________________) with renal association is called ____________________
   - Common signs include butter fly rash on face or __________________, __________________, fever, arthralgia __________________, proteinuria, hematuria and hypertension.

3. The disease process characterized by the inflammation of the blood vessels is known as ____________________________;
   - ____________________________ which affects the small and medium-sized arteries in the kidneys and respiratory tract
   - Henoch-Schonlein _____________ (HSP) involves small vessels in the __________________, kidneys, __________________ and __________________.

4. Hamburger disease is actually called ______________________________ Syndrome and is usually caused by E. coli.
   - It is characterized by ________________________________, ______________________________ and other renal and neurological manifestations.
   - HUS destroys ____________________, and occludes the ____________________ & ____________________ which ultimately results in ____________________.

1. Autosomal Dominant Polycystic Disease, 50%.
2. Systemic Lupus erythematosus, lupus nephritis, malar, photosensitivity, elevated ESR.
3. Systemic Vasculitis Wegner’s, Purpura joints, skin, GI tract Hemolytic uremia, microangiopathic hemolytic anemia, thrombocytopenia red blood cells, glomerular capillaries arterioles, ischemia.
CAUSES OF CHRONIC KIDNEY DISEASE (CKD) CONTINUED:

**Multiple Myeloma**
Approximately 20 percent of patients with multiple myeloma have impaired renal function. The chains of immunoglobulin produced in excess by the tumor cells are nephrotoxic and cause tubular damage. This is most often seen in patients with a high tumor burden and can evolve as either an acute or chronic disorder.

**Amyloidosis**
This is a systemic disorder characterized by an accumulation of abnormal fibrillar glycoprotein, which infiltrates body organs and soft tissue. Etiology is idiopathic, associated with Multiple myeloma and any chronic inflammatory condition that continually stimulates the immune response. When amyloidosis involves the kidneys, the glomerulus is damaged resulting in proteinuria. Renal involvement occurs in more than 90% of patients.

**Progressive Systemic Sclerosis: Scleroderma**
Scleroderma is a mixed connective tissue disease characterized by connective tissue proliferation and vascular lesions. It is more common in females, with 50% of patients with scleroderma developing renal ischemia and tubular changes. Glomerular ischemia commonly leads to elevated renin levels and subsequent hypertension.
**Urinary Tract Infections (UTI’s): Pyelonephritis**

Pyelonephritis is an inflammation of the renal parenchyma (cellular structure) caused by bacteria that have ascended the urinary tract into the kidney. The kidney becomes edematous from interstitial inflammation, congested circulation and tubular cell necrosis. With repeated infections, healthy renal parenchyma may be replaced with chronic scar tissue leading to chronic kidney disease.

**Chronic Drug Induced Tubulointerstitial Nephritis (TIN)**

The most common form of TIN is analgesic nephropathy resulting from long time use of prescription and non-prescription drugs such as NSAIDS, aspirin, and acetaminophen. It is characterized by renal papillary necrosis and chronic interstitial nephritis.

**Renal Artery Stenosis (RAS)**

RAS is defined as narrowing of the renal artery lumen by 50% or more. RAS results in a significant decrease in renal blood flow. This triggers the renin-angiotensin-aldosterone system with resulting vasoconstriction, retention of fluid causing volume expansion, and hypertension. RAS is due to atherosclerosis in over 90% of cases.

**Alport’s Syndrome**

Alport’s Syndrome is a genetic disorder with 85% cases related to a mutation on the X chromosome. Both males and females are affected, with the disease more severe in males. Patients often present with hematuria with or without proteinuria, with gradual progression to kidney failure in late teens or later.
Review:

1. Renal dysfunction occurs in more than 20% of people with multiple __________________. It is a tumor of plasma cells that produces excessive/decreased immunoglobulin, which then causes tubular damage in the kidneys.

2. An accumulation of abnormal fibrillar scleroprotein characterizes ___________________.
   - This damages the___________________ in the kidney.
   - More than _______% of people with amyloidosis develops renal problems.

3. The disease characterized by connective tissue proliferation is ___________________.
   - Ischemia in this part of the kidney leads to elevated/decrease levels of ___________________ and hypertension.

4. An inflammation of a renal structure caused by bacteria that have ascended the urinary tract into the kidney is called_______________.
   - Repeated infections lead to scarring of the _______________ which can lead to chronic kidney disease.

5. TIN stands for _________________________________.
   - Which can be caused by long time prescription and non-prescription _______________ use.
   - The most common form of TIN is _________________________________.

6. A narrowing of the renal ________________ by 50% or more increases/decreases renal blood flow
   - This triggers the _______________ - _______________ - _______________ system and results in ________________, retention of fluid and _________________.

1. Myeloma, excessive,
2. Amyloidosis, glomerulus, 90%, scleroderma, elevated, renin
3. Pyelonephritis, parenchyma
4. Tubulointerstitial nephritis, drug, analgesic nephropathy
5. artery, decreases, renin-angiotensin-aldosterone, vasoconstriction, hypertension
**CHRONIC KIDNEY DISEASE (CKD)**

**SUPPLEMENTAL READING:**
*CH 10, CONTEMPORARY NEPHROLOGY NURSING*
*CH 4 & CH 7, CORE CURRICULUM FOR NEPHROLOGY NURSING 5TH ED.*

CKD is defined as irreversible kidney damage for 3 months or more, or GFR < 60ml/min. Markers of damage include abnormalities in the blood or urine tests or imaging studies.

Kidney disease can be a “silent” disease and is often undetected until it is in later stages.

Early identification of patients who may be at risk for developing kidney disease is important to help prevent end stage renal disease.

The risk factors include:
- Diabetes Mellitus
- Hypertension
- Urinary tract abnormalities
- Known systemic autoimmune disorders
- Excessive use of known nephrotoxins (NSAIDS)
- Symptoms suggestive of a systemic illness

The Kidney Disease Outcome Quality Initiative (K/DOQI) working group developed a classification system of the stages of chronic kidney disease based on the level of kidney function measured by GFR.

Adverse outcomes of CKD can be based on the level of kidney function, thus the classification system provides a framework for the evaluation and development of a clinical action plan for patients with CKD. The classification system is based on the calculated GFR, which is a widely accepted approach to measure kidney function.
In addition to establishment of a diagnosis, it is important to assess the severity of kidney dysfunction and establish the stage of CKD.

Interventions during the early stages of CKD are critical in slowing disease progression. However, CKD often goes undetected because patients are frequently asymptomatic.

This diagram depicts the Manitoba Renal Program staging system, which is based on the KDOQI guidelines. There are five stages of CKD with four therapeutic zones identified before renal replacement therapy (RRT).

The amount of damage to your kidneys is categorized by five stages.

### STAGES AND THERAPEUTIC FOCUS:

**Stage 1:** prevent kidney failure  
**Stage 2:** decrease rate of decline  
**Stage 3:** decrease rate of decline  
**Stage 4:** manage complications of CKD  
**Stage 5:** prepare for renal replacement therapy

### STAGES 1, 2, 3, 4, 5

- Follow a healthy lifestyle: Healthy eating, Be physically active, Stop smoking, Limit alcohol intake.
- Take medications as prescribed
- Aim for a healthy weight
- Avoid anti-inflammatory pain medications e.g. ibuprofen, naproxen, high-dose ASA (more than 325 mg per day)
- Maintain good blood pressure (less than 130/80)
- If you have diabetes maintain good blood sugar *A1c less than 7% (blood test done at a lab)

### STAGES 4, 5

- Same as above
- Follow a prescribed kidney friendly diet

### STAGE 5

- Same as above
- May require the following:
  - Home dialysis (Peritoneal Dialysis OR Hemodialysis)
  - In Centre Hemodialysis
  - Kidney Transplant

**End-of-life care** (no dialysis or transplant)

*Chart courtesy of the www.kidneyhealth.ca*
As GFR declines, patients begin to show signs of: hypertension, a wide range of lab abnormalities, and symptoms due to disorders in other organ systems including cardiovascular complications, anemia, dyslipidemia, disorders of bone metabolism, protein energy malnutrition, neuropathy, and alterations in health status.

Complications associated with declining GFR:

Cardiovascular Disease (CVD)
CVD is very common among people with CKD. Complications can include hypertension (see below), left ventricular hypertrophy, congestive heart failure, angina, and myocardial infarction. CVD is the leading cause of death of patients with Stage 5 CKD.

Hypertension (HTN)
HTN is a leading cause of CKD but it is also a complication of CKD. Treatment of hypertension is vital in slowing progression of CKD. As kidney function declines, the kidneys ability to excrete excess sodium and water, results in fluid retention contributing to hypertension.

Chronic elevated blood pressure increases the risk of myocardial infarction, heart failure, and kidney damage.

Anemia
Anemia is common in CKD mainly due to a decline in the stimulation of red blood cell production, or erythropoietin synthesis by the kidneys and shortened life span of RBC.

Anemia is a contributing factor to left ventricular hypertrophy (LVH), congestive heart failure (CHF) and ischemic heart disease.
**Protein-Energy Malnutrition (PEM)**

The causes of PEM are multifactorial. They include:

- poor nutritional intake due to uremia induced anorexia
- increased protein catabolism caused by metabolic acidosis
- negative effect of inflammation and infection on decreasing visceral protein synthesis,
- endocrine disorders

As well, patients with later stages of CKD are often placed on restricted diets that limit the variety of foods they can eat.

**Metabolic Acidosis**

Metabolic Acidosis occurs as the number of functioning nephrons declines resulting in impaired retention and excretion of H+ (hydrogen) and HCO3− (bicarbonate) ions.

Metabolic Acidosis leads to chronic bone loss, muscle wasting, anorexia, weight loss, hypoalbuminemia, and impaired cardiac function.

**Mineral and Bone disorders**

Disturbances in mineral and bone metabolism develop as the GFR declines. Abnormal calcium and phosphorous metabolism and elevated parathyroid hormone and impaired vitamin D metabolism can lead to pruritus, renal osteodystrophy, myopathy, and soft tissue calcifications.
Neurological Disturbances
Neurological disturbances are a common characteristic of CKD caused by increased levels of uremic toxins, decreased cerebral blood flow and reduced cerebral oxygen utilization. This affects the central, peripheral and autonomic nervous system. Impairment varies directly with the rate at which renal dysfunction progresses.

Dyslipidemia
Dyslipidemia commonly occurs in patients with CKD. The typical pattern consists of elevated total cholesterol, elevated triglycerides and lowered high-density lipoprotein (HDL) cholesterol contributing to increased risk for cardiovascular disease (CVD).

Quality of Life
There is good evidence that declining GFR is associated with abnormalities in health status, work status, and general well-being.

Pregnancy and pre-existing kidney disease
Pregnancy may lead to acceleration in declining renal function with early stage CKD.

Chronic kidney disease in pregnancy increases the risk of fetal loss, preterm birth, and low birth weight. Therefore, contraception is recommended although menses may become irregular and may have stopped. Approximately 1%-7% of female patients on dialysis become pregnant.

Pregnancy following renal transplant is not uncommon, but should be avoided for 1-2 years to allow for stabilization of medications and decreased risk for graft failure.
Review:

1. What is the therapeutic focus in each stage?
   - Stage 1:
   - Stage 2:
   - Stage 3:
   - Stage 4:
   - Stage 5:

2. List 8 common complications associated with CKD.
   - 1.
   - 2.
   - 3.
   - 4.
   - 5.
   - 6.
   - 7.
   - 8.

3. The leading cause of death in people with Stage 5 CKD is ________________.

4. ________________ is both a complication and a cause of CKD.

5. The kidneys make less of the hormone, ________________, which affects red blood cell production and results in __________ in people with CKD.

6. List 3 causes of Protein-Energy Malnutrition
   - 1.
   - 2.
   - 3.

7. The impaired excretion and retention of hydrogen ions and bicarbonate ions results in ________________.

1. Prevent kidney failure, decrease rate of decline, decrease rate of decline, manage complications, prepare for RRT
2. Cardiovascular Disease, hypertension, anemia, protein-energy malnutrition, metabolic acidosis, mineral and bone disorders, neurological disturbances, dyslipidemia, metabolic acidosis, parathyroid, pruritus, bone disease, myopathy, Dyslipidemia
3. Cardiovascular disease
4. Hypertension
5. Erythropoietin (EPO), anemia
6. Poor nutritional intake, increased protein catabolism (metabolic acidosis), effect of inflammation & infection on decreasing visceral protein synthesis, endocrine disorders
7. Metabolic acidosis
8. Abnormal calcium and phosphorous metabolism and elevated ___________________ hormone can lead to:
   1. ________________
   2. ________________
   3. ________________
   4. soft tissue calcifications.

9. ___________________ is a complication that has a pattern of elevated triglycerides and lowered HDL cholesterol?

10. What causes neurological disturbance in CKD?
    ______________________________

11. Does pregnancy increase/decrease the progression of kidney disease?

12. What percentage of females may become pregnant on dialysis?
    __________

13. How long following a transplant should a patient wait before becoming pregnant?
    __________

8. Parathyroid, pruritus, bone disease, myopathy
9. dyslipidemia
10. Increased level of uremic toxins decreased cerebral blood flow and reduced cerebral oxygen utilization.
11. increase,
12. 1-7%,
13. 1-2 years
**Acute Kidney Injury (AKI)**

**Supplemental Reading:**
*CH 9, Contemporary Nephrology Nursing*
*CH 10, Core Curriculum for Nephrology Nursing 5th Ed.*

Acute kidney injury (AKI) is defined as the sudden inability of the kidneys to remove excess body fluid, minerals and waste products. There is a rapid decline in glomerular filtration rate (GFR). This change in the kidneys’ performance may be caused by trauma, post-surgery, medications, sepsis, poisoning, or as a complication of critical illness. Clinically, symptoms are often:

- Elevation in urea, creatinine and potassium
- Metabolic acidosis
- Oliguria (urine output < 500ml/day) or anuria (urine output < 100), although non-oliguria (normal urine volume) may occur
- Fluid overload for those experiencing oliguria or anuria

The prognosis for recovery of renal function varies with the cause and extent of injury. With prolonged duration of the renal injury and increased severity of the clinical symptoms, the higher the mortality rate. Overall mortality rates are approximately 50% with infection as a major cause of death. In critically ill patients, the mortality rate is as high as 85%.

**Remember:**

Acute Kidney Injury is the sudden inability of kidneys to remove excess body fluid, minerals and waste products.

Causes include Trauma, medications, poisoning, surgery or complications of a critical illness.
Three types of AKI:

Pre-renal

The kidneys are structurally normal but are damaged by reduced renal perfusion. Pre-renal causes approximately 35% of AKI cases.

Common causes of this are:

- Decreased cardiac output r/t reduced effective circulating volume (MI, pulmonary embolism, cardiac failure, septic shock, CHF)
- Uncontrolled vasodilation (sepsis, anaphylactic shock)
- Hypovolemia/hypotension (dehydration, hemorrhage, burns, GI losses)
- Renal vascular obstruction (renal artery stenosis, renal artery thrombosis)

Goal of treatment is to restore renal perfusion and decrease length of ischemic time to prevent permanent damage to kidney function. Prolonged pre-renal ARF can result in permanent damage.
**Intra-renal**

The kidney tissue itself is injured and involves structural damage to glomeruli, vessels, and renal tubules. If pre-renal causes are not controlled they will lead to intra-renal failure. Intra-renal causes approximately 50% of AKI cases.

Common causes are:
- Caused by intra-renal ischemia or toxins or both
  - Acute tubular necrosis (ATN)
  - Acute interstitial nephritis (AIN)
  - Rapidly progressive Glomerulonephritis and vasculitis r/t inflammation or immunologic disorders.

Overall, the prognosis for recovery of renal function for this type of ARF is related to the length of ischemic episode. If the underlying condition can be corrected, renal function can significantly improve.
**Post-renal**

The kidneys are structurally normal and good blood supply exists, but there is a blockage in the flow of urine along the urinary tract, Post-renal causes approximately 5-10% of AKI cases. The excessive fluid pressure causes the nephrons to shut down.

Common causes of this are:

- Obstructions (enlarged prostate glands, calculi, pregnancy, uterine prolapse)
- Tumors (pelvic mass)

Kidney function in post-renal AKI can often be restored. Recovery depends on duration and severity of the obstruction.
Review:

1. What are the three types of AKI?
   1.
   2.
   3.

2. List common symptoms of AKI?
   1. Pre-renal, intra-renal, post-renal.
   2. Elevation in urea, creatinine and potassium
      Metabolic acidosis
      Oliguria (urine output < 500ml/day) or anuria (urine output < 100), although
      non-oliguria (normal urine volume) may occur
      Fluid overload for those experiencing oliguria or anuria
   3. Decreased cardiac output
      r/t reduced effective circulating volume (MI, pulmonary embolism, cardiac failure, septic shock, CHF)
      Uncontrolled vasodilation (sepsis, anaphylactic shock)
      Hypovolemia/hypotension (dehydration, hemorrhage, burns, GI losses)
      Renal vascular obstruction (renal artery stenosis, renal artery thrombosis).

3. List common causes of Pre-renal AKI?
   1. Acute tubular necrosis (ATN)
      Ischemia, nephrotoxic agents
      Acute interstitial nephritis (AIN)
   2. Renal vascular obstruction (renal artery stenosis, renal artery thrombosis).
   3. Tumors (pelvic mass)
   4. Obstructions (enlarged prostate glands, calculi, pregnancy, and uterine prolapse)
CKD IN MANITOBA

In 2009, Manitoba was amongst the highest rates concerning incidence and prevalence rates of CKD in Canada, which was 232.4 RPMP and 1431.3 RPMP respectively in comparison to Canada’s average of 159.3 RPMP and 1118.7 RPMP respectively. According to the Canadian Institute for Health Information (CIHI), after 20 years, Canadians living with kidney failure rates appear to have stabilized.

33% of Manitobans chose transplant as a treatment strategy, which is amongst the lowest preference in relation to other provinces. This section includes some statistics to help you appreciate the context of chronic kidney disease in Manitoba.

INCIDENT ERSD, AGE-SPECIFIC RATE PER MILLION POPULATION, CANADA, 1990 TO 2009

Sources
Canadian Organ Replacement Register, 2010, Canadian Institute for Health Information; Statistica Canada.
Congratulations! Studying the information in the Self Learning Package will prepare you to enter the Manitoba Nephrology Nursing Course (MNNC) where you will develop knowledge and skills building on the Self Learning Package. When you are ready to write the Pre-Entrance Exam, please contact the Manitoba Renal Program Renal Education Department to book an appointment date and time.
References


Up-to-Date (2014) Analgesic Nephropathy

Up-to-Date (2014) Multiple Myeloma

Up-to-Date (2014) Wegner’s Granulomatosis
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