Manitoba Nephrology Nursing Course

SELF LEARNING PACKAGE
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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 renal 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.

Currently in Manitoba, there are approximately 1000+ people receiving dialysis services. Over 800 are receiving hemodialysis services, while approximately 200 patients receive peritoneal dialysis. 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 3000 patients who are followed by the Renal Health Clinics. The 2010 MRP annual budget to manage this care service was approximately $52 million.

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

- Lakeshore General Hospital (Ashern, MB)
- Dauphin Health Centre (Dauphin, MB)
- Flin Flon General Hospital (Flin Flon, MB)
- Lake of the Woods Hospital (Kenora, ON)
- 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 Dialysis Unit (Swan River, MB)
• Thompson General Hospital (Thompson, MB)
• J.A. Hildes Northern Medical Unit (Island Lakes, MB)

**Peritoneal Dialysis Services:** Peritoneal dialysis teaching and follow-up care is currently offered at the St. Boniface General Hospital and Seven Oaks General 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.

**Renal Health Clinic Services:** Renal Health Clinics focus on renal health disease prevention to delay the onset and progression of renal disease and to prepare for renal replacement therapy (hemodialysis, peritoneal dialysis...
or transplant). In Manitoba, this service is currently operated through Health Sciences Centre (HSC), St. Boniface General Hospital (SBGH), Seven Oaks General Hospital (SOGH), 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. Ongoing continuing educational events are also provided in various formats (MB Telehealth, Self Learning Packages, MRP Annual Conference, 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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Fax: 787-1573          Fax: 787-1573
Email: hkolowca@hsc.mb.ca     Email: rhanson@hsc.mb.ca

If you have questions about the Self Learning Package, you may call one of the WRHA Regional Educators 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. The Educators are prepared to assist you by phone, so please do not hesitate to call.
SITE EDUCATORS:

Health Sciences Centre
Patricia Bowers
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**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. 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>Fee Item</th>
<th>Fee Amount</th>
</tr>
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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</td>
<td>$200.00</td>
</tr>
<tr>
<td>Recommended ext Books</td>
<td>$254.95 (optional)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$454.95</strong></td>
</tr>
</tbody>
</table>

Your hiring facility will provide a stipend while you take the MNNC. Please contact your hiring facility for more information.
The recommended texts are:

*Handbook of Dialysis, 4th ed.*, Daugirdas, Blake and Ing, Wolters Klewer, Lippincott, Williams and Wilkins, 2007 ($90.95)

*Contemporary Nephrology Nursing: Principles and Practice, 2nd ed.*, Molzahn and Butera, American Nephrology Nursing Association, 2006. ($164.00)

Both 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 main components:

- Self Learning Package and Exam
- Theory and Clinical Component
- Preceptorship

**Self Learning Package and Exam:**

The Self Learning Package provides baseline knowledge of Chronic Kidney Disease, a review of the anatomy and physiology of the kidneys, as well as an overview of the treatment modalities. 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 re-write opportunity will be provided. 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 and consists of 6 weeks of classroom and clinical study. To enter into this component, you must be hired by a MRP dialysis site; the dialysis site manager will arrange for course admission. The theoretical component is provided at the Health Sciences Centre and will build upon the Self Learning Package. In this section you can expect to learn more advanced aspects of renal replacement therapies, with a focus on hemodialysis.

**Theory and Clinical Component (continued):**

Clinical experiences are available at HSC, SOGH, SBGH and BRHC. We will do our best to accommodate requests, but cannot guarantee that you will attend the site of your choice.

**Preceptorship:**

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

The successful completion of the above MNNC requirements entitles you to practice as a 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
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CRRT</td>
<td>Continuous Renal Replacement Therapy</td>
</tr>
<tr>
<td>CVAD</td>
<td>Central Venous Access Device</td>
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<tr>
<td>CVC</td>
<td>Central Venous Catheter</td>
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<tr>
<td>DCT</td>
<td>Dialysis Care Technician</td>
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<td>DDS</td>
<td>Dialysis Disequilibrium Syndrome</td>
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<td>DM</td>
<td>Diabetes Mellitus</td>
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<td>CDU</td>
<td>Central Dialysis Unit (A6/B6)</td>
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<tr>
<td>DW</td>
<td>Dry Weight</td>
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<tr>
<td>ECF</td>
<td>Extracellular Fluid</td>
</tr>
<tr>
<td>EDW</td>
<td>Estimated Dry Weight</td>
</tr>
<tr>
<td>eGFR</td>
<td>estimated Glomerular Filtration Rate</td>
</tr>
<tr>
<td>ePTFE</td>
<td>expanded Polytetrafluoroethylene</td>
</tr>
<tr>
<td>ESRD</td>
<td>End Stage Renal Disease</td>
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<tr>
<td>EPO</td>
<td>Erythropoietin</td>
</tr>
<tr>
<td>GFR</td>
<td>Glomerular Filtration Rate</td>
</tr>
<tr>
<td>GN</td>
<td>Glomerulonephritis</td>
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<tr>
<td>HBV</td>
<td>High Biological Value</td>
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<tr>
<td>HCA APD</td>
<td>Health Care Assisted Automated Peritoneal Dialysis</td>
</tr>
<tr>
<td>Hct</td>
<td>Hematocrit</td>
</tr>
<tr>
<td>HF</td>
<td>Heparin Free</td>
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<tr>
<td>HD</td>
<td>Hemodialysis</td>
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<tr>
<td>Hgb</td>
<td>Hemoglobin</td>
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<td>Hg</td>
<td>Mercury</td>
</tr>
<tr>
<td>HTN</td>
<td>Hypertension</td>
</tr>
<tr>
<td>ICF</td>
<td>Intracellular Fluid</td>
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IgA................................................................. Immunoglobulin A
IP ............................................................. Intraperitoneal (medication)
K ................................................................. Potassium
KDOQI.................................................. Kidney Disease Outcomes Quality Initiative
Kecn..............................K=clearance e= effective c=conductivity n=Na
Kt/V ...................................................... K=clearance T=time V=Urea volume
Kuf ...................................................... Ultrafiltration Coefficient
LVH.......................................................... Left Ventricular Hypertrophy
MAP......................................................Mean Arterial Pressure
MRP ........................................................ Manitoba Renal Program
MNNC................................................ Manitoba Nephrology Nursing Course
NKF KDOQI................................................ National Kidney Foundation Kidney Disease Outcomes Quality Initiative
NSAID ................................................ Nonsteroidal Anti-inflammatory Drug
NIDDM ............................................. Non-insulin Dependent Diabetes Mellitus
NS ............................................................ Normal Saline
PCR .......................................................... Protein Catabolic Rate
PD ............................................................. Peritoneal Dialysis
PKD ......................................................... Polycystic Kidney Disease
PRI .......................................................... Progressive Renal Insufficiency
PTFE...................................................... Polytetrafluoroethylene
PTH ........................................................ Parathyroid Hormone
PUR ........................................................ Percentage of Urea Reduction
PVD ........................................................ Peripheral Vascular Disease
Qa ............................................................. Access Flow Rate
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Qb</td>
<td>Blood Pump Flow Rate</td>
</tr>
<tr>
<td>Qd</td>
<td>Dialysate Flow Rate</td>
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<tr>
<td>OLC</td>
<td>Online Clearance</td>
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<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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<td>RHO</td>
<td>Renal Health Outreach</td>
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<td>RO</td>
<td>Reverse Osmosis</td>
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<tr>
<td>RRT</td>
<td>Renal Replacement Therapy</td>
</tr>
<tr>
<td>SCDU</td>
<td>Sherbrook Centre Dialysis Unit</td>
</tr>
<tr>
<td>SP</td>
<td>Single Pool (refers to Kt/V measurement)</td>
</tr>
<tr>
<td>TBW</td>
<td>Total Body Water</td>
</tr>
<tr>
<td>TCD</td>
<td>Theoretical Conductivity of Dialysate</td>
</tr>
<tr>
<td>TMP</td>
<td>Transmembrane Pressure</td>
</tr>
<tr>
<td>UFR</td>
<td>Ultrafiltration Rate</td>
</tr>
<tr>
<td>URR</td>
<td>Urea Reduction Ratio</td>
</tr>
<tr>
<td>V</td>
<td>Urea distribution Volume</td>
</tr>
<tr>
<td>WRHA</td>
<td>Winnipeg Regional Health Authority</td>
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**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.csns.cn.ca/english/home/default.asp?n=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 LEARNING OBJECTIVES

I. INTRODUCTION:

1. The nurse will be able to state the regulatory bodies that guide nephrology practice.
   a. International
   b. Canadian

II. NORMAL KIDNEY FUNCTION

1. The nurse will be able to describe the location of the kidneys.
2. The nurse will be able to state the average size of each kidney.
3. The nurse will be able to state the four key functions of the kidneys.
4. The nurse will be able to describe how many liters of blood are sifted by the kidneys each day.
5. The nurse will be able to state how the kidneys accomplish fluid and electrolyte balance.
6. The nurse will be able to state how the kidneys achieve acid base balance.
7. The nurse will be able to state three hormonal functions that the kidney is involved in.

III. MEASURING KIDNEY FUNCTION

1. The nurse will be able to state the two terms most often used in describing kidney function.
2. The nurse will be able to describe a creatinine clearance test.
3. The nurse will be able to state the normal creatinine clearance rate.
4. The nurse will be able to describe glomerular filtration rate (GFR).
5. The nurse will be able to state the normal GFR.
IV. RENAL ANATOMY AND PHYSIOLOGY

1. The nurse will be able to 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

V. RENAL CIRCULATION

1. The nurse will be able to state how much cardiac output the kidneys receive.
2. The nurse will be able to state two unique traits of the kidneys shared by no other part of the human body.
3. The nurse will be able to describe the pathway of renal circulation from the aorta to the inferior vena cava.

VI. THE NEPHRON

1. The nurse will be able to state how many nephrons are present in normal healthy kidneys.
2. The nurse will be able to locate on a diagram and give a brief description of the function of the following structures:
   a. Glomerulus
   b. Bowman’s Capsule
   c. Proximal Convoluted Tubule
   d. Loop of Henle
   e. Distal Convoluted Tubule
   f. Collecting Duct
3. The nurse will be able to state what glomerular filtrate is.
4. The nurse will be able to describe the final process of urine production as the glomerular filtrate leaves the kidney.

VII. CAUSES OF CHRONIC KIDNEY DISEASE

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. Goodpastures Syndrome
      iii. Post-infectious Glomerulonephritis
   d. Autosomal Dominant Polycystic Kidney Disease
   e. Systemic Lupus Erythematosus
   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
   m. Renal Artery Stenosis

VIII. CHRONIC KIDNEY DISEASE (CKD)

1. The nurse will be able to define chronic kidney disease including the markers of damage.
2. The nurse will be able to list the risk factors for CKD.
3. The nurse will be able to list the Stages of Kidney Disease and the therapeutic focus of each stage.
4. The nurse will be able to 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. Dyslipedemia
   i. Quality of life
   j. Pregnancy and pre-existing renal disease

IX. ACUTE RENAL FAILURE (ARF)

1. The nurse will be able to define acute renal failure.
2. The nurse will be able to state by what percentage the GFR may decrease.
3. The nurse will be able to describe the clinical symptoms of ARF.
4. The nurse will be able to state the overall mortality rates.
5. The nurse will be able to state the three main types of ARF and where/how the kidney damage occurs.
6. The nurse will be able to state the most common causes of pre-renal failure.
7. The nurse will be able to state the most common causes of intra-renal failure.
8. The nurse will be able to state the most common causes of post-renal failure.

X. CKD IN MANITOBA

1. The nurse will be able to discuss ESRD incidence in Manitoba and Canada.
2. The nurse will be able to discuss ESRD prevalence rates in Manitoba and Canada.
3. The nurse will be able to describe approximate numbers of people on hemodialysis, peritoneal dialysis and followed through renal health clinics in Manitoba.

4. The nurse will have limited understanding of relationship of diabetes and ESRD in Canada.
I. SLP INTRODUCTION:
The field of medicine that studies kidneys and diseases of the kidney is called nephrology. “Nephro” is from an ancient Greek word 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.csns scn.ca.

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/.

II. NORMAL KIDNEY FUNCTION
SUPPLEMENTAL READING CH 4, CONTEMPORARY NEPHROLOGY NURSING

The kidneys are two essential, bean-shaped organs, each about the size of an average fist or a conventional computer mouse. 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 two to three litres of waste product and water (called urine) each day. The waste is generated from end products of food, body metabolism, and environmental factors such as drugs and water-soluble toxins. Waste products include substances such as urea, creatinine, and uric acid.

   The kidneys filter out ________________ litres of waste products and water daily called _________________. Urea, uric acid and ________________ are substances in the waste products.

2. **Body fluids and electrolytes balance.** Healthy kidneys excrete and resorb varying amounts of water and other substances such as potassium, sodium, chloride and phosphorus. The amount of urine 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.

   Potassium, ________________, sodium and ________________ are substances the kidneys excrete and _________________. Waste product, _________________, is regulated by two hormones: _________________ and _________________. These two hormones regulate the total volume of _________________, the _________________ of urine and the specific amount of

4 MAIN FUNCTIONS OF THE KIDNEYS:
- *Removal of waste products*
- *Balance electrolytes & fluids*
- *Balance pH*
- *Hormonal & Enzymatic functions*
such as sodium, potassium and chloride.

ADH is produced by the hypothalamus, suppresses the secretion of urine, and results in retention of water.

Aldosterone is produced by the adrenal cortex and regulates the volume of blood and extracellular fluid primarily by the reabsorption of sodium by the kidneys.

When the extracellular volume is too high, the blood volume is 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.

ADH stands for _________________. Does ADH increase or inhibit the secretion of urine?

Aldosterone regulates the volume of blood and ________________, mainly through the reabsorption of sodium, abbreviated as __________________.

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.
Circle the correct response:

ADH ↑, urine secretion (↑ or ↓ or no change). When extracellular fluid volume ↓, the kidneys (excrete fluid/retain fluid).

Cross down, retain fluid

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 increases excretion of bicarbonate (a base) and increases reabsorption of hydrogen ions (acid). If the body pH is low, called *acidosis*, the kidneys decrease the excretion of bicarbonate and decrease the absorption of hydrogen ions.

*Normal body fluid pH is between _______________________. Alkalosis means ______________________ while acidosis means ______________________. If the pH is too high, the body wants to make the fluid more ______________________ so ↓/↑ the excretion of bicarbonate and ↓/↑ of hydrogen ions.*

4. Hormonal and Enzymatic functions

a. The kidneys are partially responsible for the conversion of Vitamin D to its active metabolite. This is important for the formation of bone and chemical balance in the body.

**REMEMBER:**

*Vitamin D is important for bone formation and chemical balance*

*Erythropoietin stimulates red blood cell production*

*Renin is released by the kidney when BP is low*
b. Erythropoietin is secreted by the kidney in response to low hemoglobin. This hormone stimulates the bone marrow to make red blood cells.

   c. 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.

Why is the conversion of Vitamin D important in the body?

What is one effect of Erythropoietin not being secreted by the kidneys?

Releasing renin causes blood pressure to _________________.

Section II Review: What are the 4 main functions of kidneys?

1. __________________________
2. __________________________
3. __________________________
4. __________________________

Fill in the blanks or circle the correct responses:

Urine contains waste products such as (creatinine, uric acid, aldosterone, potassium, sodium, ADH, urea, chloride). The two hormones that regulate the amount of urine are ______________________ and ______________________. ADH results in retention/excretion of water.
Do the kidneys help regulate pH in the body?  Yes/No

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

If the pH is too high (acidosis/alkalosis), the kidneys excrete more ____________________ and increase absorption of ____________________.

Extracellular volume increases, blood volume (increases/decreases) which (increases/decreases) cardiac output. Increased cardiac output (increases/decreases) arterial pressure which causes the kidneys to (increase/decrease) excretion. Kidneys may be unable to excrete fluid due to disease which cases the extracellular spaces to (expand/contract) to accommodate the extra fluid.

**III. Measuring Kidney Function**

**Supplemental Reading Ch 8, Contemporary 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 milliliters/minute (ml/min). Normal creatinine clearance for adults is 75-125 ml/min/1.73m².
Creatinine clearance test compares the level of ________________ in urine with the creatinine level in _________________. Normal creatinine clearance is ________________ ml/________/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,
- is freely filtered and not reabsorbed, and
- is minimally secreted by the kidneys.

Normal GFR for adults is 125ml/min.

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.

Creatinine blood: 75-125 µmol/minute.
IV. RENAL ANATOMY AND PHYSIOLOGY
SUPPLEMENTAL READING CH 4, CONTEMPORARY NEPHROLOGY NURSING

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.
Fill in the blanks:

The ______________________ is where the renal blood vessels, lymphatics, nerves and the ureters enter or exit the kidney.

The **renal artery** is the main artery that carries blood ______________________ the kidney.

The **renal vein** is the main vein that carries ______________________ away from the kidney.

The **capsule or renal capsule** is a fibrous layer covering the kidney. The **cortex** is the outer layer of the kidney and is underneath the ______________________. The cortex contains ~80-85% of the nephrons (cortical nephrons) and their blood vessels.

The **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/away from) 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**.

The inner portion of the kidney where the **major calyces** meet to empty the urine is called the ______________________ ______________________.

The **ureter** exits the renal pelvis and transports urine to the ________________.

---

**V. RENAL CIRCULATION**

**SUPPLEMENTAL READING CH 4, CONTEMPORARY NEPHROLOGY**

**NURSING**

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.

Oxygenated blood leaves the heart via the **aorta** and branches off at the **renal artery** to enter the kidney at the _________________. From the renal artery, the renal circulatory system branches into the **interlobar arteries**, which are situated between the papillae. The oxygenated blood travels through the **arcuate arteries** which run along the border between the medulla and the cortex. Arcuate arteries divide into **interlobular arteries** and then the **afferent arterioles**. The afferent arterioles supply the **glomerular**
capillaries where glomerular filtration occurs. The blood and remaining fluid in the glomerular capillaries drain into the efferent arterioles. One set of efferent arterioles lead to the peritubular capillary network, which provide an extensive blood supply to the cortex of the kidney. The other set of efferent arterioles, closest to the medulla, send branches into the medulla, forming the vasa recta, which feeds the medulla. Now that the blood has been filtered and has nourished the kidney, it continues back to the heart via the renal vein and the inferior vena cava.
Note: this arrangement: afferent arteriole → glomerular capillaries → efferent arteriole is the only place in the body where capillaries join to arteries.

Note: the two sets of capillary beds in one system

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VI. THE NEPHRON

SUPPLEMENTAL READING CH 4, CONTEMPORARY NEPHROLOGY

NURSING

The nephron is the powerhouse of the kidney. Filtration of the blood and reabsorption of substances occurs in this apparatus. There are approximately 1-1.5 million nephrons in each normal healthy kidney.

What is the normal glomerular filtration rate in a healthy kidney? (from Section III)

a) 115 ml/min
b) 125 ml/min
c) 130 ml/min

125 ml/min

The glomerulus is where the glomerular capillaries are located and where filtration occurs. Pressure created by the heart forces water, electrolytes, urea, creatinine, uric acid, glucose, protein 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 liters of glomerular filtrate each day! The glomerulus is located in the Bowman’s capsule or Bowman’s space which is the area that collects the glomerular filtrate.
Where does filtration occur in the kidneys? ______________________. The collected filtrated substance is called ______________________
____________________ and is collected in the ______________________ capsule.

Glomerulus, Glomerular filtrate, Bowman's capsule.
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 two-thirds of the glomerular filtrate is reabsorbed into the bloodstream. In addition to ______________ filtrate, plasma, water, nutrients and electrolytes are also reabsorbed.

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. Like the proximal ______________ tubule, the loops of Henle are responsible for reabsorbing electrolytes and small amounts of plasma water. The **distal convoluted tubule** is in between the loop of Henle and the collecting ducts. Like the proximal convoluted tubule, the distal convoluted
tubule is located in the ______________________ 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. If ADH (________ _________________ ________________) is present, water absorption occurs; 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 _________________ , ________________, ________________, drugs and electrolytes (sodium, potassium and phosphate, etc.). (Refer to Section II if required.)

VII. CAUSES OF CHRONIC KIDNEY DISEASE (CKD)

SUPPLEMENTAL READING CH 6 & CH 7, CONTEMPORARY NEPHROLOGY NURSING

Diabetes Mellitus
Diabetic nephropathy is a long term complication of Diabetes Mellitus that occurs when the small capillaries of the glomerulus are damaged from years of high blood sugar. The glomerulus thickens resulting in glomerulosclerosis defined as scarring or hardening of the blood vessels in the kidney. Both Type 1 and Type 11 DM can cause CKD. Although not all people with
diabetes will develop CKD, the risk increases if the blood glucose is poorly controlled.

**Hypertension**
Prolonged hypertension can cause nephrosclerosis, a term that refers to “hardening of the kidney.” Untreated hypertension can lead to sclerosis of the renal arterioles, 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**
*Glomerulonephritis (GN)* refers to a complex group of disease processes affecting the glomerulus. GN is an inflammation of the glomerulus leading to an impairment of renal function partly due to the formation of antibody/antigen complexes, which are deposited within the glomerulus. Patients with glomerular diseases present with abnormalities in the urine, such as proteinuria, due to damage to the filtrating membrane. 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. 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 alveolar capillaries in the lungs and to the glomerulus.
• **Postinfectious Glomerulonephritis (PIGN)** can occur after a streptococcal infection of either the upper respiratory tract or of the skin. The streptococcal infection causes inflammation of the small blood vessels of the glomerulus. PIGN is rare before age 2, but common in school aged children, and can occur at any age in adults. There is usually a 7-14 day latent period after a respiratory infection and 21-28 days after a skin infection. Children often respond fully to medical management, but complete recovery in adults is less certain.

The complication resulting from diabetes mellitus is called ________________________________ which affects the kidneys by eventually causing glomerulosclerosis. Glomerulosclerosis means ____________________________________________________________.

The main complication affecting the kidneys that results from hypertension is called _____________________________. This term means “hardening of the kidney.” People present with the following:

__________________________, ____________________________,
__________________________, ____________________________.

There are ___________ main types of glomerulonephritis which is diagnosed through a renal ______________________. Generally, GN is an inflammation of the glomerulus leading to an impairment of renal function partly due to the formation of ______________________ complexes, which are deposited within the glomerulus. Patients with glomerular diseases present with abnormalities in the ______________________, such as proteinuria.
The most common type of glomerulonephritis is called _________________. When the body develops an autoimmune response to the alveolar capillaries in the lungs and to the glomerulus, a condition called ________________ results.

Children often fully recover from ________________ which occurs after a ________________ infection of the upper respiratory tract or the skin.

Autosomal Dominant Polycystic Kidney Disease (ADPKD)

ADPKD is the most common inherited kidney disease which affects both males and females. Normal kidney tissue is replaced with grape-like clusters that compress and destroy the surrounding tissue. ADPKD affects both men and women of all ethnic groups. Complications include hypertension, painful rupture of cysts, hemorrhagic cysts, hematuria, urinary tract infections, 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 Erythematos (SLE)

SLE is a chronic systemic inflammatory disorder of the connective tissues resulting from the formation of auto antibodies. Female to male ratio occurrence is 9:1. Renal involvement is referred to as Lupus Nephritis and is clinically present in 50% of patients at the time of diagnosis. Immune complexes are deposited in the glomerular capillaries and an inflammatory response follows, which 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.

**Wegner’s Granulomatosis** predominantly affects the small and medium sized arteries of the kidneys and respiratory tract. The exact cause is not known.

**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, suggesting the possibility of an infectious etiology in some patients.

*ADPKD which stands for ____________________________ is the most common inherited kidney disease and about ______% of people with ADPKD will develop End Stage Renal Disease. Complications include ____________________________ , ____________________________,
  ____________________________ , ____________________________,
  ____________________________ , ____________________________,
  painful rupture of cysts, hemorrhagic ____________, and nephrolithiasis.

*SLE, ____________________________ , ____________________________, overwhelmingly occurs in females. The renal association is called ____________________________, Common signs and
symptoms include a butterfly rash on the face called a ___________________, ___________________, arthralgia, ___________________, fever, ___________________, hypertension and ___________________.

The disease characterized by the inflammation of the blood vessels is known as ___________________ has two main types that affect the kidneys: Wegner’s ___________________ which affects the small and medium-sized arteries in the kidneys and respiratory tract and Henoch-Schonlein ___________________ (HSP) involves small vessels in the ___________________, kidneys, ___________________, ___________________ and ___________________.

Thrombotic Microangiopathy: Hemolytic Uremic Syndrome
This a disease characterized by microangiopathic hemolytic anemia, thrombocytopenia, and various renal and neurological manifestations. 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 sometimes necrosis.

Multiple Myeloma
Multiple Myeloma is a tumor of plasma cells in the bone marrow that produces excessive immunoglobulin (M protein). The chains of immunoglobulin produced in excess are nephrotoxic and cause tubular damage. Renal dysfunction occurs in more than 50% of patients.

**Amyloidosis**

Amyloidosis is a systemic chronic disease characterized by an accumulation of abnormal fibrillar scleroprotein, which infiltrates body organs and soft tissue. When amyloidosis involves the kidneys, the glomerulus is damaged. 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. In patients with renal involvement, the disease results in narrowing of the lumen of the small interlobular and arcuate arteries. Glomerular ischemia commonly leads to elevated renin levels and subsequent hypertension.

*Hamburger disease is actually called ___________________________
_________________________ Syndrome and is usually caused by E. coli 0157:H7.

*It is characterized by ___________________________ ___________________________
_________________________ and other renal and neurological manifestations.

*HUS destroys ___________________________ ___________________________
_________________________ which ultimately results in
_________________________ and occasionally necrosis.

Renal dysfunction occurs in more than 50% of people with multiple ___________________________, a tumor of bone marrow plasma cells which produces __________________________ immunoglobulin which then causes
tubular damage in the kidneys.
An accumulation of abnormal fibrillar scleroprotein characterizes ___________ which damages the ________________ in the kidney. More than ______% of people with amyloidosis develop renal problems.

The narrowing of lumen of interlobular an arcuate arteries is caused by _________________. Ischemia in this part of the kidney leads to (elevated/decreased) levels of ________________ and hypertension.

Urinary Tract Infections (UTI’s): Pyelonephritis
Pyelonephritis is an inflammation of the renal parenchyma (structure) caused by bacteria that have ascended the urinary tract into the kidney. With repeated infection, healthy renal parenchyma may be replaced with chronic scar tissue leading to chronic kidney disease.

Chronic Drug Induced Tubulointerstitial Nephritis (TIN)
Chronic drug induced TIN is a form of CKD that results from long time use of prescription and non-prescription drugs. The most common form is analgesic nephropathy. This form of nephritis causes inflammation to the tissues of the kidneys surrounding the renal tubules. The inflammation of the tissues damages the renal tubules. TIN can occur with prolonged use of medications such as NSAIDS, aspirin, and acetaminophen.
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, which triggers the renin-angiotensin-aldosterone system with resulting vasoconstriction, retention of fluid with volume expansion, and hypertension. RAS is caused by atherosclerosis in over 90% of cases.

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.

TIN stands for ________________________ _________________________ which can be caused by long time prescription and non-prescription __________________________ use. The most common form of TIN is ________________________ _________________________ .

A narrowing of the renal artery _____________________ by 50% or more (increases/decreases) renal blood flow which triggers the ___________________ / ___________________ / ___________________ system and results in ______________________, retention of fluid and ___________________.

Vasocostrictor, hypertension
Lumen, decreases, renin, angiotensin/aldosterone
Tubulointerstitial nephritis, drug, anesthetic nephropathy
Pyelonephritis, parenchyma
VIII. CHRONIC KIDNEY DISEASE (CKD)

SUPPLEMENTAL READING: CH 10, CONTEMPORARY NEPHROLOGY NURSING

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 widely accepted as the best measure of kidney function in health and disease.

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).

### Progression of Chronic Kidney Disease: Stages and Therapeutic Focus

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Prevent Kidney Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>Decrease Rate of Decline</td>
</tr>
<tr>
<td>(Declining GFR to 60 ml/min/1.73m²)</td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td>Manage CRK Complications</td>
</tr>
<tr>
<td>(GFR 30-60 ml/min/1.73m²)</td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>Prepare for RRT</td>
</tr>
<tr>
<td>(GFR below 30 ml/min/1.73m²)</td>
<td></td>
</tr>
<tr>
<td>Stage 5</td>
<td>Renal Replacement Therapy</td>
</tr>
<tr>
<td>(GFR below 15 ml/min/1.73m²)</td>
<td></td>
</tr>
</tbody>
</table>

*Chart courtesy of the Manitoba Renal Program.*

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)** is very common among people with CKD and 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** is a leading cause of CKD but it is also a complication of CKD. The higher the blood pressure the greater the risk of myocardial infarction, heart failure, and kidney damage. Improved BP control decreases progression of CKD.

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

**Protein-Energy Malnutrition (PEM)** causes 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, and 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** occurs as the number of functioning nephrons declines resulting in impaired retention and excretion of H+ (hydrogen) and HCO3^− (bicarbonate) ions.

**Disturbances in Mineral and Bone Metabolism** develops as the GFR declines. Abnormal calcium and phosphorous metabolism and elevated parathyroid hormone can lead to pruritis, bone disease, myopathy, and soft tissue calcifications.
Neurological Disturbance is a common characteristic of CKD. Increased levels of uremic toxins have correlated with reduction of nerve conduction velocity and peripheral manifestations of neuropathy. Cognitive impairment may also occur as a result of uremia and anemia.

Dyslipidemia is common in patients with CKD. The typical pattern consists of elevated triglycerides and lowered high-density lipoprotein (HDL) cholesterol.

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

Pregnancy and Pre-existing Renal Disease: Mild renal impairment at the onset of pregnancy is associated with a low risk of decline in renal function. 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 the first year (living donor) or two years (deceased donor) to allow for stabilization of immunosuppression.

What is the therapeutic focus in each stage?

Stage 1:

Stage 2:

Stage 3:

Stage 4:

Stage 5:
There are 10 common complications associated with CKD. List them:

The leading cause of death in people with Stage 5 CKD is
____________________.
____________________ is both a complication and a cause of CKD.

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

List 3 causes of Protein-Energy Malnutrition:
The impaired excretion and retention of hydrogen ions and bicarbonate ions results in ______________________ ________________

Abnormal calcium and phosphorous metabolism and elevated ______________________ hormone can lead to ______________________

____________________, ______________________ and soft tissue calcifications.

Which complication has a pattern of elevated triglycerides and lowered HDL cholesterol? ______________________

Why might neurological disturbance result from CKD?

______________________________________________________________________________________________

IX. ACUTE RENAL FAILURE (ARF)

SUPPLEMENTAL READING: CH 9, CONTEMPORARY NEPHROLOGY NURSING

Acute renal failure 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) by greater than 50%. This change in the kidneys’ performance may be caused by trauma, surgical procedure,
medications, poisoning, or as a complication of critical illness. Clinically, symptoms are often:

- Elevation in urea, creatinine and potassium
- Metabolic acidosis
- Oliguria (urine output < 400) 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. The longer the duration of the renal injury and the more severe the clinical symptoms, the higher the mortality rate. Overall mortality rates are approximately 50% and infection is the major cause of death. In critically ill patients, the mortality rate is as high as 85%.

There are three main types of ARF.

1. **Pre-renal.** In this type of ARF, the kidneys are structurally normal but are damaged by the lack of blood supply to the kidney. Common causes of this are:
   - Decreased cardiac output (CHF, MI, pulmonary embolism)
   - Uncontrolled vasodilation (sepsis, anaphylactic shock)
   - Hypovolemia/volume depletion (hemorrhage, burns, GI losses)
   - Renal vascular obstruction (renal artery stenosis, renal artery thrombosis)

Kidney function can be recovered if blood supply to the kidney can be re-established. Prolonged pre-renal ARF can result in permanent damage.
2. **Intra-renal.** In this type of ARF, the kidney tissue itself is injured and involves structural damage to glomeruli, vessels, and renal tubules. Pre-renal causes that are not controlled will lead to intra-renal failure. Common causes of intra-renal ARF are:

- Large vessel injury (renal artery stenosis, thrombosis, emboli, endocarditis, tumor, a-fib)
- Small vessel injury (scleroderma, HUS, vasculitis, postpartum, medications)

Overall, the prognosis for recovery of renal function for this type of ARF is poor. If the underlying condition can be corrected, renal function can significantly improve.
3. **Post-renal.** In this type of ARF, the kidneys are structurally normal and good blood supply exists, but there is a blockage in the flow of urine along the urinary tract. The excessive fluid pressure causes the nephrons to shut down. Common causes of this are:
   - Obstructions (enlarged prostate glands, bladder stones, pregnancy, uterine prolapse)
   - Tumors

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

![Diagram of post-renal ARF](image)

What are the three types of ARF?

*In which types of ARF are the kidneys structurally normal?*

*In which types of ARF can kidney function be restored?*
X. CKD IN MANITOBA

In 2009, Manitoba is amongst the highest rates concerning incidence and prevalence rates of ERSD in Canada, which is 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), that after 20 years, the number of Canadians living with kidney failure rates are now appearing to stabilize. Also, 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**

![Graph showing age-specific rates per million population for incident ERSD in Canada, 1990 to 2009.](image)

Sources

Canadian Organ Replacement Register, 2010, Canadian Institute for Health Information; Statistics Canada.
PREVALENCE RATE FOR PATIENTS ON DIALYSIS OR WITH FUNCTIONING TRANSPLANT IN CANADA, 1990 TO 2009 (RATE PER MILLION POPULATION)

Sources
Canadian Organ Replacement Register, 2010, Canadian Institute for Health Information; Statistics Canada.
CONCLUSION

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


