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## Patient information: Renal replacement therapy

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*UpToDate performs a continuous review of over 375 journals and other resources. Updates are added as important new information is published. The literature review for version 15.3 is current through August 2007; this topic was last changed on August 29, 2006. The next version of UpToDate (16.1) will be released in March 2008.*

**INTRODUCTION** — Renal replacement therapies are treatments for severe kidney failure, also called renal failure, stage 5 chronic kidney disease, and end-stage renal disease. When the kidneys are no longer working effectively, waste products and fluid build up in the blood. Renal replacement therapies take over a portion of the function of the failing kidneys to remove the fluid and waste.

Renal replacement therapy is typically needed when about 90 percent or more of kidney function is lost. This usually takes many months or years after kidney disease is first discovered, although sometimes severe kidney failure is discovered for the first time in patients who were not previously known to have kidney disease. Early in the course of kidney disease, other treatments are used to help preserve kidney function and delay the need for replacement therapy. Treatments are directed at the underlying disease, secondary factors (such as hypertension) that promote disease progression, and the complications of chronic kidney disease.

As the kidneys lose their ability to function, fluid and waste products begin to build up in the blood. Abnormalities in blood chemistries, malnutrition, high blood pressure (hypertension), bone disease, and anemia can also occur as a direct result of kidney failure. When these problems reach a critical stage, renal replacement therapy is required.

There are three types of renal replacement therapy: kidney transplantation, hemodialysis, and peritoneal dialysis. This topic review discusses these therapies, including the advantages, disadvantages, and care required for each. Patients and family should discuss all of the options with their healthcare provider in order to make an informed decision.

**KIDNEY TRANSPLANTATION** — Kidney transplantation is considered the treatment of choice for many patients with severe chronic kidney disease because quality of life and survival are often improved, compared patients who use dialysis. However, there is a shortage of organs available for donation, so many patients who are candidates for transplantation are put on a transplant waiting list and require other forms of renal replacement therapy until an organ is available.

A kidney can be taken from a living relative, a living unrelated person, or from a person who has died (deceased or cadaver donor); a person only requires one kidney to survive. In general, organs from living donors function better and for longer periods of time than those from donors who are deceased.

Some patients with renal failure are not candidates for a kidney transplant. Older age and severe heart or vascular disease may mean that it is safer to remain on dialysis rather than undergo kidney transplantation. Other conditions that exclude a person from being eligible for transplantation include:

- Untreated current infection
- Active or recently treated cancer
- A chronic illness that results in a life expectancy of less than a few years
- Poorly controlled mental illness (psychosis)
- Severe obesity (a body mass index greater than 40, [show table 1A-1B](#))
- Inability to remember medications
- Active drug or alcohol abuse

Most centers exclude patients who test positive for HIV. In selected cases, however, patients may be eligible for transplantation if they have well-controlled HIV-infection.

Patients with other medical conditions are also evaluated on a case-by-case basis to determine their suitability for transplant.

**Advantages** — Kidney transplantation is the treatment of choice for many patients with end-stage renal disease. A successful kidney transplant can improve the quality of life and reduce the risk of death for many patients when compared to patients who receive dialysis. In addition, patients who undergo transplantation are free of the time- and energy-consuming requirements of dialysis.

**Disadvantages** — Kidney transplantation is a major surgical procedure that has risks associated with the procedure as well as the treatment regimen following transplantation. The procedure-associated risks include infection, bleeding, and damage to the surrounding organs. Even death can occur, but this is very rare. After transplantation, patients must take immunosuppressive medications and are monitored for signs of organ rejection; both are required for the lifetime of the patient. Immunosuppressive medications can have significant and bothersome side effects in many patients.

**HEMODIALYSIS** — In hemodialysis, the patient's blood is pumped through a dialysis machine to remove waste products and excess fluids. The machine works by putting the patient's blood in contact with a special solution, called dialysate. The blood is separated from the dialysate by a membrane that allows substances to move (diffuse) from the blood to the dialysate. Substances that are in high concentrations in the blood, such as the waste products the kidney normally removes, are in lower concentration or not present in the dialysate. The process of diffusion causes these substances to move from the blood across the membrane and into the dialysate. The blood is continuously returned to the body and the dialysate is continuously replaced with fresh solution. ([See "Patient information: Hemodialysis"](#)).

The patient is connected to the dialysis machine using a surgically created path called a vascular access, usually referred to as an access. This allows blood to be

removed from the body, circulate through the dialysis machine, and then return to the body.

The best type of access, called an arteriovenous (AV) fistula, is surgically created between an artery and a vein in the lower arm. It needs to be placed two to four months before it can be used for dialysis. If construction of an AV fistula is not possible, a plastic tube, called a graft, can be used to create the path. This type of access can be used in two weeks. A third type of access, a central venous line, can be placed (usually in the neck) and can be used immediately. However, it is more prone to complications than the other types of access and should only be used if no other route is available.

Hemodialysis can be done at a dialysis center or at home. When done in a center, it is generally done three times a week and takes between three and five hours per session.

Home dialysis is generally done three to seven times per week and takes between three and ten hours per session. Daily dialysis is often done for about three to four hours four to seven days each week. Overnight dialysis (called "nocturnal hemodialysis") is typically done three to seven times weekly while the patient is sleeping. Additional time is needed to prepare and clean up. Home dialysis can be done at a time that is convenient for the patient. Patients are generally required to have someone else (a family member, friend, or technician) to assist them before, during, and after dialysis. A healthcare provider must be available by telephone in case questions or problems arise; some machines allow the patient to be monitored remotely via the telephone or internet.

A daily (or nightly) dialysis schedule provides substantial benefits compared to in-center three times weekly hemodialysis. More frequent dialysis results in a significant improvement in patient well being, reduces symptoms during and between dialyses, and improves quality of life. Home hemodialysis can improve a patient's quality of life because it allows them to assume more responsibility for their own care and allows them to remain in the comfort of their home during treatment. In addition, patients who use home hemodialysis are often able to continue working.

**Advantages** — It is not known if hemodialysis has clear advantages over the other type of dialysis (peritoneal dialysis) in terms of patient survival. The choice between the two types of dialysis is generally based upon other factors, including patient preference, home supports, and underlying medical problems. Patients begin with the type of dialysis that they and their doctors think is best, although it is possible to switch to another type as circumstances and preferences change.

**Disadvantages** — Low blood pressure is the most common complication of hemodialysis and can be accompanied by lightheadedness, shortness of breath, abdominal cramps, nausea, or vomiting. Treatments and preventive measures are available for these potential problems. In addition, the access can become infected or develop blood clots. Many patients who receive hemodialysis in a center are either unable to work or choose not to work due to the time required for treatment and transportation.

**PERITONEAL DIALYSIS** — Peritoneal dialysis is typically done by the patient or family member at home. It requires that someone be trained in the use of the equipment

and that the patient have a catheter surgically inserted in the abdomen. The catheter is made of a soft, flexible material and is usually placed near the umbilicus (belly button); the patient may receive general or local anesthesia during the insertion procedure. Although the catheter can be used right away, it is best to wait 10 to 14 days after placement before a full course of treatment is used; this allows the catheter site to heal.

In peritoneal dialysis, dialysis fluid (called dialysate) is infused into the abdomen through the catheter. The fluid is held within the abdomen for a prescribed period of time (called a dwell). The lining of the abdomen (the peritoneal lining) acts as a membrane to allow excess fluids and waste products to diffuse from the bloodstream into the dialysate. During each cycle (often called an exchange) the dialysate in the abdomen is drained out and discarded. The peritoneal cavity is then filled again with fresh dialysate.

This may be done manually four to five times during the day by infusing the fluid into the abdomen and later allowing it to run out by gravity. The process of emptying and filling for each exchange takes 30 to 40 minutes when done manually. The exchange may also be done using a machine (called a cycler).

Several different treatment schedules are possible.

- Continuous ambulatory peritoneal dialysis (CAPD) involves multiple exchanges during the day (usually four, but sometimes three or five) with an overnight dwell. The dialysate is infused into the abdomen at bedtime and is drained upon awakening.
- Continuous cycler peritoneal dialysis (CCPD) is an automated form of therapy in which a machine performs exchanges while the patient sleeps; there may be a long daytime dwell, and occasionally a manual daytime exchange is performed.

Patients are often allowed to choose between CAPD and CCPD based upon lifestyle or personal issues (such as the need for a partner with CCPD). CCPD generally allows significantly more uninterrupted time for work, family, and social activities than CAPD.

**Disadvantages** — Disadvantages of peritoneal dialysis include an increased risk of hernia (weakening of the abdominal muscles) from the intraabdominal pressure of the dialysate. In addition, patients require several hours per day to perform exchanges (if performing CAPD), can gain weight due to glucose absorption (from the dialysate), have an increased risk of infection at the catheter site or inside the abdomen (peritonitis), and can absorb excessive amounts of fluid during long dwell times.

**CHOOSING REPLACEMENT THERAPY** — Choosing the most appropriate method of renal replacement therapy is a complex decision that is best made by the patient and doctors, and often other family members or caregivers, after careful consideration of a number of important factors.

For example, hemodialysis involves rapid changes of the fluid balance in the body and is not tolerated well by some patients. Some patients are not suitable candidates

for transplant, while others may not have the home supports or abilities needed to do peritoneal dialysis. The patient's overall medical condition, personal preferences, and home situation are among the many factors that should be considered in examining the options for renal replacement. It is possible for patients to switch from one modality to another if preferences or conditions change over time.

Kidney transplantation is the optimal treatment for most patients. Patients who are not candidates for transplantation or who must wait for a kidney can usually be treated with either hemodialysis or peritoneal dialysis.

**STARTING THERAPY** — As kidney disease progresses, the decision to begin dialysis is made by the patient and doctor after considering a number of factors, including the patient's kidney function (as measured by blood and urine tests), overall health, quality of life, nutritional status, and personal preferences. Dialysis should begin before kidney disease has advanced to the point where life-threatening complications occur. It is best to begin dialysis treatments when the patient has advanced kidney disease requiring renal replacement therapy, but while the patient still feels well, is not malnourished, do not have severe metabolic or other complications of their kidney failure, and do not have severe salt or fluid overload.

Certain clinical signs indicate that dialysis must be started immediately. If blood tests measuring kidney function show severe kidney failure, or if the patient has confusion or bleeding related to kidney disease, dialysis should be started immediately.

Patients with kidney disease should discuss the possible need for renal replacement therapy early in their treatment. Advance planning can help reduce complications and may allow the patient to plan for treatment. If hemodialysis will be used, advance planning allows time for the placement of an AV fistula, which usually requires at least two to four months to heal before it can be used. Similarly, allowing sufficient time to train the patient and/or family to perform home hemodialysis or peritoneal dialysis can ensure that those involved are prepared when dialysis treatments need to begin.

**WHERE TO GET MORE INFORMATION** — Your healthcare provider is the best source of information for questions and concerns related to your medical problem. Because no two patients are exactly alike and recommendations can vary from one person to another, it is important to seek guidance from a provider who is familiar with your individual situation.

This discussion will be updated as needed every four months on our web site ([www.patients.uptodate.com](http://www.patients.uptodate.com)). Additional topics as well as selected discussions written for healthcare professionals are also available for those who would like more detailed information.

A number of web sites have information about medical problems and treatments, although it can be difficult to know which sites are reputable. Information provided by the National Institutes of Health, national medical societies and some other well-established organizations are often reliable sources of information, although the frequency with which they are updated is variable.

- National Library of Medicine

([www.nlm.nih.gov/medlineplus/healthtopics.html](http://www.nlm.nih.gov/medlineplus/healthtopics.html))

- National Institute of Diabetes and Digestive and Kidney Diseases

([www.niddk.nih.gov](http://www.niddk.nih.gov))

- National Kidney Foundation

(800) 922-9010  
([www.kidney.org](http://www.kidney.org))

- United Network for Organ Sharing (UNOS)

(888) 894-6361  
([www.unos.org](http://www.unos.org))

- American Kidney Fund

([www.akfinc.org](http://www.akfinc.org))

- Home Dialysis Central

([www.homedialysiscentral.org](http://www.homedialysiscentral.org))

- Kidney School

([www.kidneyschool.org](http://www.kidneyschool.org))

[1-3]

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2. Galla, JH. Clinical practice guideline on shared decision-making in the appropriate initiation of and withdrawal from dialysis. The Renal Physicians Association and the American Society of Nephrology. *J Am Soc Nephrol* 2000; 11:1340.
3. Williams, AW, Chebrolu, SB, Ing, TS, et al. Early clinical, quality-of-life, and biochemical changes of "daily hemodialysis" (6 dialyses per week). *Am J Kidney Dis* 2004; 43:90.

## GRAPHICS

### Determining BMI A

### Determining body mass index from weight and height

|                        | Good weights    |     |     |     |     |     |     | Overweight |     |     |     |     | Obesity |     |
|------------------------|-----------------|-----|-----|-----|-----|-----|-----|------------|-----|-----|-----|-----|---------|-----|
| BMI, kg/m <sup>2</sup> | 19              | 20  | 21  | 22  | 23  | 24  | 25  | 26         | 27  | 28  | 29  | 30  | 35      | 40  |
| Height, inches*        | Weight, pounds* |     |     |     |     |     |     |            |     |     |     |     |         |     |
| 58"                    | 91              | 96  | 100 | 105 | 110 | 115 | 119 | 124        | 129 | 134 | 138 | 143 | 167     | 191 |
| 59"                    | 94              | 99  | 104 | 109 | 114 | 119 | 124 | 128        | 133 | 138 | 143 | 148 | 173     | 198 |
| 60"                    | 97              | 102 | 107 | 112 | 118 | 123 | 128 | 133        | 138 | 143 | 148 | 153 | 179     | 204 |
| 61"                    | 100             | 106 | 111 | 116 | 122 | 127 | 132 | 137        | 143 | 148 | 153 | 158 | 185     | 211 |
| 62"                    | 104             | 109 | 115 | 120 | 126 | 131 | 136 | 142        | 147 | 153 | 158 | 164 | 191     | 218 |
| 63"                    | 107             | 113 | 118 | 124 | 130 | 135 | 141 | 146        | 152 | 158 | 163 | 169 | 197     | 225 |
| 64"                    | 110             | 116 | 122 | 128 | 134 | 140 | 145 | 151        | 157 | 163 | 168 | 174 | 204     | 232 |
| 65"                    | 114             | 120 | 126 | 132 | 138 | 144 | 150 | 156        | 162 | 168 | 174 | 180 | 210     | 240 |
| 66"                    | 118             | 124 | 130 | 136 | 142 | 148 | 155 | 161        | 167 | 173 | 179 | 186 | 216     | 247 |
| 67"                    | 121             | 127 | 134 | 140 | 146 | 153 | 159 | 166        | 172 | 178 | 185 | 191 | 223     | 255 |
| 68"                    | 125             | 131 | 138 | 144 | 151 | 158 | 164 | 171        | 177 | 184 | 190 | 197 | 230     | 262 |
| 69"                    | 128             | 135 | 142 | 149 | 155 | 162 | 169 | 176        | 182 | 189 | 196 | 203 | 236     | 270 |
| 70"                    | 132             | 139 | 146 | 153 | 160 | 167 | 174 | 181        | 188 | 195 | 202 | 209 | 243     | 278 |
| 71"                    | 136             | 143 | 150 | 157 | 165 | 172 | 179 | 186        | 193 | 200 | 208 | 215 | 250     | 286 |
| 72"                    | 140             | 147 | 154 | 162 | 169 | 177 | 184 | 191        | 199 | 206 | 213 | 221 | 258     | 294 |
| 73"                    | 144             | 151 | 159 | 166 | 174 | 182 | 189 | 197        | 204 | 212 | 219 | 227 | 265     | 302 |
| 74"                    | 148             | 155 | 163 | 171 | 179 | 186 | 194 | 202        | 210 | 218 | 225 | 233 | 272     | 311 |
| 75"                    | 152             | 160 | 168 | 176 | 184 | 192 | 200 | 208        | 216 | 224 | 232 | 240 | 279     | 319 |
| 76"                    | 156             | 164 | 172 | 180 | 189 | 197 | 205 | 213        | 221 | 230 | 238 | 246 | 287     | 328 |

The health risk from any level of BMI is increased if the patient has gained more than 5 kg (11 pounds) since age 25, or if the waist circumference is above 100 cm (40 in) due to central fatness

\* Divide weight by 2.2 to convert pounds into kilograms; multiply height by 2.54 to convert inches into centimeters.

## Determining BMI B

### Determining body mass index using kilograms and centimeters\*

| <b>BMI,<br/>kg/m<sup>2</sup></b> | <b>19</b>          | <b>20</b> | <b>21</b> | <b>22</b> | <b>23</b> | <b>24</b> | <b>25</b> | <b>26</b> | <b>27</b> | <b>28</b> | <b>29</b> | <b>30</b> | <b>35</b> | <b>40</b> |
|----------------------------------|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Height,<br/>cm*</b>           | <b>Weight, kg*</b> |           |           |           |           |           |           |           |           |           |           |           |           |           |
| <b>147</b>                       | 41                 | 43        | 45        | 48        | 50        | 52        | 54        | 56        | 58        | 61        | 63        | 65        | 76        | 86        |
| <b>150</b>                       | 43                 | 35        | 47        | 50        | 52        | 54        | 56        | 59        | 61        | 63        | 65        | 68        | 79        | 90        |
| <b>152</b>                       | 44                 | 46        | 49        | 51        | 53        | 55        | 58        | 60        | 62        | 65        | 67        | 69        | 81        | 92        |
| <b>155</b>                       | 46                 | 48        | 50        | 53        | 55        | 58        | 60        | 62        | 65        | 67        | 70        | 72        | 84        | 96        |
| <b>158</b>                       | 47                 | 50        | 52        | 55        | 57        | 60        | 62        | 65        | 67        | 70        | 72        | 75        | 87        | 100       |
| <b>160</b>                       | 49                 | 51        | 54        | 56        | 59        | 61        | 64        | 67        | 69        | 72        | 74        | 77        | 90        | 102       |
| <b>162</b>                       | 50                 | 52        | 55        | 58        | 60        | 63        | 66        | 68        | 71        | 73        | 76        | 79        | 92        | 105       |
| <b>165</b>                       | 52                 | 54        | 57        | 60        | 63        | 65        | 68        | 71        | 74        | 76        | 79        | 82        | 95        | 109       |
| <b>168</b>                       | 54                 | 56        | 59        | 62        | 65        | 68        | 71        | 73        | 76        | 79        | 82        | 85        | 99        | 113       |
| <b>170</b>                       | 55                 | 58        | 61        | 64        | 66        | 69        | 72        | 75        | 78        | 81        | 84        | 87        | 101       | 116       |
| <b>173</b>                       | 57                 | 60        | 63        | 66        | 69        | 72        | 75        | 78        | 81        | 84        | 87        | 90        | 105       | 120       |
| <b>175</b>                       | 58                 | 61        | 64        | 67        | 70        | 74        | 77        | 80        | 83        | 86        | 89        | 92        | 107       | 123       |
| <b>178</b>                       | 60                 | 63        | 67        | 70        | 73        | 76        | 79        | 82        | 86        | 89        | 92        | 95        | 111       | 127       |
| <b>180</b>                       | 62                 | 65        | 68        | 71        | 75        | 78        | 81        | 84        | 87        | 91        | 94        | 97        | 113       | 134       |
| <b>183</b>                       | 64                 | 67        | 70        | 74        | 77        | 80        | 84        | 87        | 90        | 94        | 97        | 100       | 117       | 134       |
| <b>185</b>                       | 65                 | 68        | 72        | 75        | 79        | 82        | 86        | 89        | 92        | 96        | 99        | 103       | 120       | 137       |
| <b>188</b>                       | 67                 | 71        | 74        | 78        | 81        | 85        | 88        | 92        | 95        | 99        | 102       | 106       | 124       | 141       |
| <b>190</b>                       | 69                 | 72        | 76        | 79        | 83        | 87        | 90        | 94        | 97        | 101       | 105       | 108       | 126       | 144       |

|            |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
|------------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| <b>193</b> | 71 | 74 | 78 | 82 | 86 | 89 | 93 | 97 | 101 | 104 | 108 | 112 | 130 | 149 |
|------------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|

\* The health risk from any level of BMI is increased if the patient has gained more than 5 kg (11 pounds) since age 25, or if the waist circumference is above 100 cm (40 in) due to central fatness.