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# How To Do It

# Spreadsheet Use to Calculate Creatinine Clearance From Serum Creatinine

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**Abstract:** Spreadsheets may be created to include the Cockcroft-Gault Formula (CGF) for creatinine-based estimation of glomerular filtration rate. Creatinine clearance (CrCl) provides a more accurate method for perioperative risk assessment of renal function than serum creatinine. CrCl may be used to develop guidelines for renal protective management strategies during cardiopulmonary bypass. CGF uses serum creatinine, age, kilogram weight, sex, and "logical test" functions within the spreadsheet to calculate the CrCl. Implementation of spreadsheets has the potential for numerous other calculations and may provide an accurate and consistent method of clinical perfusion management.
**Keywords:** Cockcroft-Gault Formula, creatinine clearance, serum creatinine, glomerular filtration rates, body surface area. *JECT. 2007;39:260–262*

The use of serum creatinine (SCr) as an index of renal function has a limited ability to identify patients with preoperative renal insufficiency (1). Patients may have significantly decreased glomerular filtration rates (GFR) with normal SCr values (2). The Cockcroft-Gault formula (CGF) for calculating creatinine clearance (CrCl) may provide a more accurate assessment of renal reserve because it takes into consideration age, sex, and muscle mass (3). The addition of a creatinine-based estimation of GFR within an existing spreadsheet may provide a useful and convenient means to assess renal function. CrCl may be used as a guideline for perioperative risk assessment and renal protective management strategies during cardiopulmonary bypass (CPB).

## DESCRIPTION

Spreadsheets are commonly used to calculate information regarding body surface area (BSA), flow rates for cardiac index (CI), and cardiac output (CO). The spreadsheet we presently use has been modified to include a pre-CPB patient data section that features drop-down menus (Figure 1). The input values are as follows: height, weight, age, sex, hematocrit, aprotinin use, and SCr. The input values are used in corresponding formulas to calculate BSA, CO, CI, heparin dose, protamine dose, circulating blood volume, red cell volume, post-dilutional bypass hematocrit, body mass index (BMI), and CrCl. Using relatively few data input values, numerous calculations may be performed simultaneously within the spreadsheet. The spreadsheet program we presently use is Microsoft Excel version 2003 (Microsoft, Redmond, WA). In the toolbar menu under the data heading, the validation feature is used within the spreadsheet program to incorporate list boxes. The list boxes feature drop-down menus that allow the user to select input values. In the pre-CPB patient data section (Figure 2), patient values are entered in the appropriate cells, and the corresponding units are selected from the drop-down list boxes. In the height and weight input cell, either centimeters or inches and kilograms or pounds may be selected, respectively. BSA and CIs are calculated from 1.6 to 2.8 L/min/m$^2$ with the corresponding cardiac outputs to determine arterial pump flow rates. This CO/CI flow chart is routinely used to correlate swan-ganz cardiac output to cardiac index after termination of CPB. The formulas are incorporated within the sheet using the "logical test" functions within the spreadsheet. Using this technique, the formulas are altered as to which list box is selected. The use of the "IF" function within the formula specifies the "logical test" to be performed. The

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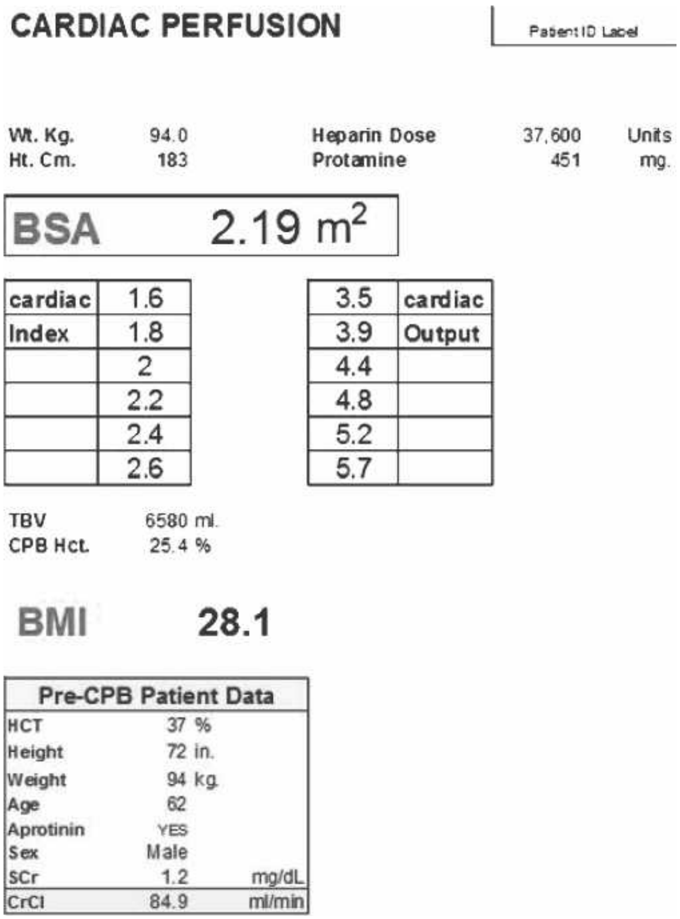


**Figure 1.** Spreadsheet with pre-CPB patient data.

use of the list boxes in combination with the "logical test" functions allow for multiple calculations using minimal data input cells.

## THE COCKCROFT-GAULT FORMULA

$$\text{CrCl} = (140 - \text{Age}) \times \text{mass (kilogram weight)} \div 72 \times \text{SCr in (mg/dL) if "female"} \times 85\%$$

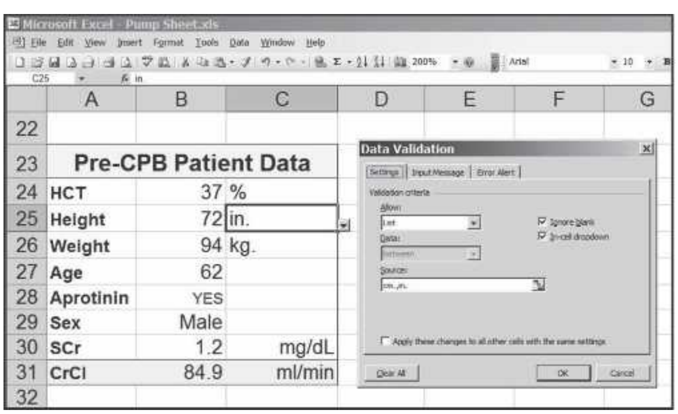


**Figure 2.** Pre-CPB data showing list boxes for input cells.

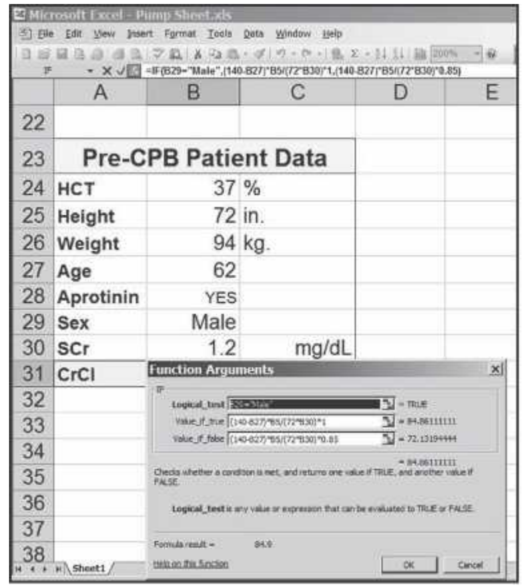


**Figure 3.** Cockcroft-Gault function arguments using the "logical test" equation.

The corresponding pre-CPB data input values are used in combination with the "logical test" functions to calculate the CrCl (Figure 3). The "logical test" functions allow the equation to be modified depending on which value is selected in the list box. This feature permits alternate calculations to be performed within the spreadsheet. If "female" is selected in the drop-down list box, the equation is multiplied by 85%. The estimated CrCl may then be corrected for BSA, which allows a more precise and accurate estimate of true GFR (4). The BSA corrected formula is as follows:

$$\text{Calculated CrCl} \times (1.73 \div \text{BSA}) \; (=\text{mL/min/1.73m}^2).$$

## CrCl LOGICAL TEST EQUATION

= IF (B29 = "Male", (140 – B27)*B5/(72*B30)*1,
(140 – B27)*B5/(72*B30)*0.85)

The CGF to calculate CrCl is the most widely used clinical equation to estimate creatinine-based GFR (5). GFR may provide a more accurate preoperative screening method to predict adverse outcomes in higher-risk patient populations undergoing coronary artery bypass surgery (CABG) than routinely used SCr (2). The use of SCr has important limitations because the GFR may be reduced by 75% before SCr becomes abnormal (6). The conclusions of Brown et al. (7) were that patients with significant SCr increases (≥50%) after CABG surgery have a higher 90-day mortality compared with patients with less significant increases. They also mention that the identification and preservation of patients with impaired renal function before cardiac surgery may benefit future patients. The CGF that estimates CrCl may be used to identify and set up

**Table 1.** The National Kidney Foundation renal insufficiency guidelines.

| Renal Function | GFR (mL/min) |
|---|---|
| Normal | >90 |
| Mild | 60–90 |
| Moderate | 30–60 |
| Severe | <30 |

protocols for the optimal management of patients. The following assessment guidelines from the National Kidney Foundation are used to define renal function (8). Normal renal function is defined as a CrCl of 90 mL/min or greater. Mild, moderate, and severe renal dysfunction is defined as CrCl values of 60–90, 30–60, and <30 mL/min, respectively (Table 1).

## DISCUSSION

The implementation of CrCl within a spreadsheet may provide a more accurate assessment of renal function than SCr. CrCl may be used to develop renal protection management strategies during CPB. These strategies may be customized to meet individual needs, thus potentially optimizing patient outcomes. The use of CrCl provides a simple method to identify patients with renal dysfunction. This information may be used clinically to prompt the use of strategies to treat or prevent renal insufficiency including the use of ultrafiltration or cardiopulmonary management strategies aimed at improving renal perfusion. Mangano et al. (9) has heightened the awareness of whether or not to use aprotinin in patients with compromised renal function. The use of a spreadsheet that calculates CrCl may contribute to the overall clinical decision-making process of which antifibrinolytic is administered. The CGF may be inaccurate in elderly patients because of reduced muscle mass; however, there is no precise formula for estimation of GFR in elderly patient populations (10). This calculated CrCl provides useful information that allows the assessment of renal function preoperatively. Spreadsheets have the potential for numerous calculations, should reduce the potential for mathematical errors, and may provide an accurate and consistent method of clinical perfusion management. Spreadsheet use may be incorporated into the new technology of handheld personal digital assistants (PDAs). The use of handheld PDAs may provide a portable, convenient, and useful means to perform spreadsheet calculations intraoperatively.

## REFERENCES


1. Wijeysundera Duminda N, Keyvan K, Scott B, et al. Improving the identification of patients at risk of postoperative renal failure after cardiac surgery. Anesthesiology. 2006;104:65–72.
2. Noyez L, Plesiewicz I, Verheugt FW. Estimated creatinine clearance instead of plasma creatinine level as prognostic test for postoperative renal function in patients undergoing coronary artery bypass surgery. Eur J Cardiothorac Surg. 2006;4:461–5.
3. Cockcoft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron. 1976;16:31–41.
4. Smilde TD, van Veldhuisen DJ, Navis G, Voors AA, Hillege HL. Drawbacks and prognostic value of formulas estimating renal function in patients with chronic heart failure and systolic dysfunction. Circulation. 2006;114:1572–80.
5. Levey AS, Bosch JP, Lewis JB, et al. A more accurate method to estimate glomerular filtration rate from serum creatinine: A new prediction equation. Ann Intern Med. 1999;130:461–70.
6. Kellen M, Aronson S, Roizen MF, Banard J, Thisted RA. Predictive and diagnostic tests of renal failure: A review. Anesth Analg. 1994; 78:134–42.
7. Brown JR, Cochran RP, Dacey LJ, et al. Perioperative increases in serum creatinine are predictive of increased 90-day mortality after coronary artery bypass graft surgery. Circulation. 2006;114(Suppl 1):I409–13.
8. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis. 2002; 39(Suppl 2):DI–S246.
9. Mangano DT, Tudor IC, Dietzel C. The risk associated with aprotinin in cardiac surgery: For the Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation. N Engl J Med. 2006;54:353–65.
10. Burkhardt H, Bojarsky G, Gretz N, Gladisch R. Creatinine clearance, Cockcroft-Gault formula and cystatin C: Estimators of true glomerular filtration rate in the elderly? Gerontology. 2002;483: 140–6.