Biocompatibility has been at center stage since the first evaluation of a dialytic semi-permeable artificial membrane was developed to separate blood from its cleaning solution. The use of an inert plastic membrane and the body’s reaction to it captivated the dialysis world. Patients’ reaction to various membranes found its way from the research bench to bedside quickly. As the membranes developed, they were also evaluated by what solutes they were capable of removing.

Tagged as the ultimate surrogate for uremia, the small molecule of urea is noted to be the measured substance by which dialysis dose is determined. The idea of solute removal and an association with better outcome was well established and thought to be the basis for dialysis success. Attempts at using other marker substances were less predictive. The search for that “middle molecular weight” toxin and a removal/benefit ratio was an ever-elusive goal of dialytic clinical research. After all, the kidney removes a number of substances much larger than urea and, thus, improvement in outcome might also follow an artificial membrane with similar characteristics.

But why stop there? The kidney is a living membrane and we are dealing with multiple permutations of a dead plastic membrane separating blood from its cleaner. What if cells were added? What if those cells were actually functional renal cells? What if we could produce an extracorporeal system that mimicked the functional unit (the nephron) of a human kidney? The natural kidney has an apparatus that initially filters blood (glomerulus) to produce a filtrate, which flows through a conducting tubule.
Dear Colleagues,

Welcome to the first edition of Nephrology News: A Physician’s Newsletter from the Department of Nephrology and Hypertension. We are pleased to share with you the latest information regarding the patient care, research and innovations of our department. Please look for future issues that will continue to highlight the progress we are making in the areas of nephrology and hypertension.

The focus of the Cleveland Clinic’s Department of Nephrology and Hypertension during the next year will encompass a redesign of the traditional models of patient care delivery, recruiting the very best talent, and a renewed emphasis on innovation.

In order to deliver even better patient care, we are examining the concept of professional service firms (PSF). PSF emphasize talent, innovation and attention to the customer, which includes both the patient and the payer. The department will gradually move to five focused PSF theme areas, which include chronic kidney disease, dialysis (inpatient and outpatient), hypertension, renal diseases (i.e., glomerulonephritis, metabolic stone diseases, etc.) and transplantation. Each firm will shift its philosophy to a team approach based on best demonstrated processes of care. PSF will help guide us from “reactive” disease care to ongoing “health management” that matches patient needs to professional skill sets, and from tracking patient lab data to assessing overall clinical outcomes using the electronic medical record.

The history of innovation in the Department of Nephrology and Hypertension extends back to the department’s creation in 1959; and yet innovation extends beyond devices and laboratory discoveries to valuable predictive tools applicable to clinical practice. Physicians and researchers have outlined how we should apply different formulas for predicting residual renal function based on our extensive GFR database. In addition, leveraging data from the ICU cardiothoracic database at Cleveland Clinic, a risk prediction tool examining the chance of needing dialysis post cardiac surgery based on pre-op data has been devised. And work from the department has been presented at the annual meeting for the Society for Vascular Medicine and Biology that suggests our traditional approach to defining cardiovascular risk in CKD should include additional markers such as ankle brachial index.

We also have learned that several factors from living kidney donors (i.e., systolic BP, cholesterol and GFR) are linked independently and perhaps cumulatively to long-term allograft function and may warrant greater attention during the pre-transplant evaluation process.

Cleveland Clinic has always been on the cutting edge of artificial organ technology and its human application. The Department of Nephrology and Hypertension, in collaboration with the Biomedical Engineering Department of the Lerner Research Institute, is developing an Innovations Center in Extracorporeal Therapy, spearheaded by Emil Paganini, M.D., with the goal of creating and applying new technology that will improve patient outcomes.

In 2008, the Department of Nephrology and Hypertension will relocate to the Glickman Tower, adjacent to the new Cleveland Clinic Heart and Vascular Institute. We are excited about this move and the opportunities it offers for our patients, staff and faculty.

We look forward to continuing our relationship with you and to continued collaboration on patient care into the future.

Sincerely yours,

Martin Schreiber, Jr., M.D.,
Chairman, Department of Nephrology and Hypertension

From the Chairman
Dialysis Membrane Technology

Continued from cover

and is altered by the cells lining the tubule. The proximal (early) tubule is the site of the majority of this activity because it has the function of selective and passive reabsorption, as well as the production of altered products and enzymes.

We have been involved with H. David Humes and the University of Michigan in both the bench and early human trials of just such an extracorporeal device – the Renal Assist Device (RAD). This apparatus has two focused areas of activity: pure filtration using a standard plastic membrane and an anatomically and physiologically active bioartificial tubule with human proximal cells grown on the membrane. The fluid passes from the filter through the tubule, as it would in the natural kidney. This flow allows the human cells to begin to process that fluid and either extract or add substances to both the forming urine and the blood that is receiving the biological products, similar to what happens around the normal human renal tubule.

Initial human clinical trials were done to establish the safety of adding the RAD device to a standard hemofiltration support system in ICU patients with acute renal failure (ARF). Based upon these results, a phase IIa study was performed to establish a potential for effectiveness. Outcomes of patients using the additional RAD on the hemofiltration circuitry (renal bioreplacement therapy) showed a marked improvement compared to outcomes of patients on hemofiltration therapy alone. As of this writing, the project has moved into a finalized phase II clinical trial at 10 centers. Phase III will follow in short order. The initial results using RAD are quite encouraging, with a reduction in both immediate and 28-day mortality for patients with ARF.

The use of bioartificial interfaces is becoming more feasible as technology advances both in cell generation and membrane development. Joint research efforts by Cleveland Clinic’s Departments of Nephrology and Biomedical Engineering are ongoing, striving for the next evolution of cell/membrane interface. Nano-technology and application of these newly-developed membranes as support structures for metabolically-active cells are the next area of scrutiny. As these efforts approach their clinical application, we hope to have already defined the cellular activity necessary to be supported on these membranes and perhaps even begin considering implantation.

Cleveland Clinic is ranked among the top three hospitals in the nation in the 2006 U.S. News & World Report’s physician poll. The magazine’s “America’s Best Hospitals” survey ranks our Nephrology and Hypertension program 3rd in the nation. Cleveland Clinic is named among the nation’s best in all 16 specialties surveyed, and better than any other Ohio hospital in 14 of them. For complete details, visit clevelandclinic.org.
Corin Enzyme – An Elegant Link Between the Heart and Kidney

Qingyu Wu, M.D., Ph.D.
Departments of Molecular Cardiology and
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Learner Research Institute

Three centuries after English physician William Harvey discovered the human circulatory system, Adolfo de Bold, an Argentinean scientist working in Canada, revealed a more sophisticated cardiac function in regulating kidney action. To avoid the catastrophic consequences associated with hypertension, the heart makes a hormone called atrial natriuretic peptide (ANP). When blood pressure increases and the heart muscles are stretched, the heart sends ANP out to boost salt and urine output in the kidney and to relax blood vessels. As a result, ANP lowers blood pressure by reducing intravascular volume and systemic vascular resistance. This elegant mechanism has been exploited clinically by using ANP and its related molecules as a new therapy to clear excessive body fluid build-up in patients with end-stage congestive heart failure.

In heart muscle cells, ANP is made as an inactive precursor, pro-ANP, which is later converted into the active form by a proteolytic enzyme on the cell surface. For years, many researchers hunted for this pro-ANP convertase, but the molecule remained elusive. Recently, we have discovered a membrane serine protease – corin – from the heart and shown that corin converted pro-ANP to biologically active ANP in cell-based assays. By knocking out the corin-producing gene, we created a corin-deficient mouse to test the biological importance of corin in animals.

Corin-deficient mice have elevated levels of pro-ANP but no detectable levels of ANP, demonstrating that corin is the physiological pro-ANP convertase, and that, without it, pro-ANP cannot be activated in the body. Corin-deficient mice developed spontaneous hypertension, which was exacerbated after dietary salt loading and during pregnancy – further evidence that corin is critical to maintaining normal blood pressure and salt-water balance. In collaboration with Dr. Daniel Dries at University of Texas at Southwestern Medical Center in Dallas, we have found two single nucleotide polymorphisms (SNPs) in the corin gene that are associated with hypertension in African-Americans.

All these data show that corin is an essential molecule in the ANP-mediated pathway linking the heart and kidneys. Now our laboratory is using biochemical and genetic approaches to understand the biology of this newly-identified enzyme. Our studies should help to elucidate the molecular basis of hypertension and may lead to new strategies for treating hypertension and heart diseases.
Living Donor Kidney Transplantation

The number of living donor kidney transplants now exceeds the number of deceased donor transplants each year in the United States. This is a reflection of both the ongoing shortage of quality cadaver organs for transplantation as well as the technological advances that have improved the safety of donor nephrectomy, says Cleveland Clinic nephrologist Saul Nurko, M.D.

“The introduction of laparoscopic donor nephrectomy has proven to be one of the most significant influences on increasing the number of living renal donor transplants at our center,” Dr. Nurko says. Cleveland Clinic surgeons have been using the minimally invasive technique since 1997 and currently perform more than 90 percent of donor nephrectomies laparoscopically.

As one of the busiest kidney transplant centers in the United States, Cleveland Clinic performed 280 adult kidney transplants between 2003 and 2005. Of those, 164 were living donor transplants, and one-year survival for this group of patients was 96.57 percent. Three-year survival for living donor transplant recipients at Cleveland Clinic is 93.3 percent. These results are in line with national averages as reported by the United Network for Organ Sharing (UNOS).

Most transplant centers now promote living donor transplantation as the best option for patients, Dr. Nurko says. “Living donor transplantation offers significant advantages to patients,” he explains. “The organ is of the highest quality because the donor is thoroughly tested before transplantation; the transplant can be scheduled before the recipient’s kidney function has deteriorated to the critical stage; and the preservation time for the organ is minimal.”

Time to transplantation is also minimal with a living donor. At Cleveland Clinic, the time from which the potential donor is identified until the transplant is performed is about three to six months. In contrast, the average wait for a deceased donor organ is more than three years, according to the National Kidney Foundation.

Highest success rates are achieved with living related kidney allografts because the organs have less immunologic disparity. However, advances in immunosuppression and the detection and treatment of antibody-mediated rejection “have opened the door for living donor transplantation from genetically unrelated donors,” Dr. Nurko notes. “This has increased the pool of prospective donors without compromising outcomes.”

To further expand the utilization of living donor kidney allografts, Cleveland Clinic is one of a select group of transplant centers nationwide that participates in the UNOS “Living Donor Exchange Registry.” In the event that a living donor and an intended recipient are incompatible, donor and recipient are placed on a registry to identify another incompatible donor and recipient pair at another participating institution with whom a trade can be arranged.

“This paired donor consortium ensures maximum utilization of all living donors for the benefit of patients,” Dr. Nurko says. Patients and donors are advised at their initial medical evaluation of the potential exchange in the event that they are not compatible with each other, he adds.

Any medical condition with the potential to compromise renal function is a contraindication for living kidney allograft donation, including hypertension, hepatitis, renal cancer, diabetes and HIV-positive status.

To refer patients and donors for evaluation, please call the Cleveland Clinic Transplant Center at 216.444.6996, or toll-free 800.223.2273, ext. 46996.
The Combined Effect of Low eGFR and Low ABI on Mortality

Yin Ping Liew, M.D., and Martin Schreiber, Jr., M.D.

The identification of patients at high risk for poor outcome offers the potential for intensive intervention aimed at extending life years. Seemingly, there are a number of traditional laboratory tests and clinical maneuvers that we use in our practices to define a patient’s risk. And yet we continually need to examine which test or combination of new and standard information help in identifying the high-risk patient.

Both peripheral arterial disease (PAD) and chronic kidney disease (CKD) are prevalent in the general population, especially in the elderly with traditional cardiovascular risk factors. The data from National Health and Nutrition Examination Survey (NHANES) III suggest that more than 8 million people in the United States have reduced kidney function defined by GFR <60ml/min/1.73m2. Recent data have shown that chronic kidney disease, even at a mild stage, is a powerful independent predictor of cardiovascular mortality and all-cause mortality.

PAD defined by an ankle brachial index (ABI) <0.9 is highly prevalent in CKD (GFR<60) with prevalence rate of 24-32% (7, 8). ABI <0.9 has been shown to be associated with increased cardiovascular and all-cause mortality (9, 10). The American Heart Association (AHA) has recommended using ABI as a screening tool to detect subclinical disease in the prevention of cardiovascular mortality.

We hypothesized that the combination of both PAD and CKD has incremental effects on mortality compared to either abnormality alone.

We studied 1031 patients after excluding 51 patients with eGFR <15 (mean age 66 12, 67% male, 80% white, 26% diabetic) who had ABI and serum creatinine recorded within 90 days in 1999. GFR was estimated by using the MDRD equation. Mortality data was collected from the Social Security Death Index. Cox Regression was used to estimate the risk of death for the 4 groups of eGFR + ABI: eGFR ≥60 + ABI ≥0.9, eGFR ≥60 + ABI <0.9, eGFR <60 + ABI ≥0.9, eGFR <60 + ABI <0.9 adjusted for age, gender, race, DM and SBP.

Patients with a low eGFR + low ABI had a higher risk of death than those with an eGFR ≥60 + low ABI for years 0-2 (Hazard Ratio [HR]=3.97, p<0.001) and years 2-4 (HR=2.72, p<0.001), and a higher risk of death than those with a low eGFR + ABI ≥0.9 for years 0-2 (HR= 6.80, p=0.01) and years 2-4 (HR=1.92, p=0.02). For years 4-6, the risk of death did not differ significantly between the low eGFR + low ABI group and groups with a single abnormality. We conclude that combination of Stage 3-4 CKD and PAD predicts significantly higher mortality than either disease alone. The mortality risk is especially high during the first two years of follow-up.

Both eGFR and ABI should be obtained at baseline for patients with either CKD or PAD. These tests are simple, noninvasive, inexpensive and practical for the primary care setting. Aggressive early cardiovascular risk modification could potentially improve survival rates.
Women and ARF
After Heart Surgery

Definitive evidence of female gender as a risk factor for acute renal failure following open heart surgery was first reported by Cleveland Clinic nephrologists and cardiothoracic anesthesiologists in 2003. Although acute renal failure is associated with increased mortality in this population, accurate preoperative risk assessment and preventive perioperative management have resulted in a steady decline in mortality since then, reports Emil Paganini, M.D., Section Head, Dialysis and Extracorporeal Therapy.

Preoperative risk assessment is conducted using a predictive model developed at Cleveland Clinic based on data from the more than 33,000 patients in the original study and validated in a separate cohort. The model uses 20 variables, including age, gender, LVF and type of cardiac surgery (valve only, valve plus CABG, CABG alone) to assign a severity score. Based on this score, four risk categories of increasing severity (scores 0 to 2, 3 to 5, 6 to 8, and 9 to 13) were established.

“Patients are categorized into one of four risk levels, which accurately predict what patients will require postoperative dialysis,” Dr. Paganini explains. Across the four categories, risk of postoperative acute renal failure and dialysis ranges from 0.5 percent to 22.1 percent. Published in 2005, the scoring system is now in use at major institutions across the country for clinical and research applications.

Cleveland Clinic cardiovascular surgeons are doing a series of protective maneuvers to help all patients, particularly those with high risk scores.

Currently in development is a biomarker profile that will provide the means for earlier postoperative diagnosis of acute renal failure, Dr. Paganini says. “This will mean potentially earlier intervention to prevent or reverse decline in kidney function.”

He notes that the patient’s preoperative renal status is the most important prognostic indicator for women who experience acute renal failure following open heart surgery. “Women with normal renal function are likely to recover fully, whereas those with the most compromised renal function preoperatively are likely to require permanent dialysis,” he explains.

“Additionally, at equivalent degrees of postoperative renal dysfunction, mortality risk is greater for those women with a lower preoperative GFR and in those who develop a 30 percent or greater decline in postoperative GFR not requiring dialysis.”

To prepare for appropriate perioperative management, Dr. Paganini recommends that women with existing renal disease, risk factors for acute renal failure or compromised kidney function undergo a comprehensive acute renal failure risk assessment prior to valve, CABG, a combined procedure or other cardiac surgery.

For more information or to refer patients, please contact Dr. Paganini at 216.444.5792 or paganie@ccf.org.
New Staff

Qingyu Wu, M.D., Ph.D.
Departments of Molecular Cardiology and Nephrology and Hypertension
Learner Research Institute

Dr. Wu recently discovered a cardiac enzyme, corin, that is responsible for the production of cardiac hormones critical for maintaining normal blood pressure and salt-water balance (see article, pg. 4.) The focus of his research is to understand the biology of corin and its role in cardiovascular diseases such as hypertension and heart failure. Dr. Wu previously worked at Berlex Biosciences in Richmond, Calif.

Clinical Trials

Chronic Kidney Disease CRIC
CRIC- Chronic Renal Insufficiency Cohort

The goal of this study sponsored by the NIH is to learn more about kidney disease and its effect on the heart. Three thousand participants from across the country with signs of kidney problems will be enrolled for up to 6 years. Cleveland Clinic will enroll approximately 185 subjects.

Polycystic Kidney Disease HALT

This is a large randomized NIH-sponsored clinical drug trial to determine the impact of intensive blockage of the renin-angiotensin-aldosterone system (RAAS) and the level of blood pressure control on progressive renal disease in individuals with early or more advanced stages of autosomal dominant polycystic kidney disease (ADPKD). Subjects will be divided into different treatment groups with varying blood pressure control goals using Lisinopril (ACE) or Telmisartan (ARB). Participants will be followed for 4-6 years. Cleveland Clinic will enroll 51 subjects.

Acute Renal Failure
VA#530 Cooperative Study

This study is a combined effort of the Department of Veterans Affairs (VA) and the NIH. Both government agencies seek to learn how dialysis dosing affects the survival rate in critically ill patients with acute renal failure. The study will enroll approximately 1,200 patients at 31 hospitals across the country. Cleveland Clinic will enroll approximately 90 subjects.

Renal Transplant Immunology CTOT

The purpose of this non-interventional NIH study is to determine whether any single test or a combination of tests can predict the risk of acute rejection, damage to the transplanted kidney, or loss of the transplanted kidney. A total of 360 kidney transplant recipients/donors at six centers in the United States and Canada will be enrolled. Participants will be followed for two years. Cleveland Clinic will enroll 60 subjects.
Selected Publications from the Department of Nephrology and Hypertension


Stephany BR, Augustine JJ, Krishnamurthi V, Goldfarb DA, Flechner SM, Braun WE, Hricik DE, Dennis VW, Poggio ED. Differences in qualitative proteinuria and graft function in de novo sirolimus-based versus calcineurin inhibitor-based immunosuppression in live donor kidney transplantation. (Accepted by Transplantation Feb 2006, in press)

Bravo EL. Pheochromocytoma, thyroid disease, and hyperparathyroidism. J Clin Hypertens (Greenwich) 7:173-77, 2005


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Specialty interests: Chronic kidney disease, diabetic nephropathy, acute and chronic dialytic therapies, continuous ambulatory peritoneal dialysis (CAPD), dialysis complications, cardiorenal syndrome

William E. Braun, M.D.
Phone: 216.444.6995
Specialty interests: Medical renal transplantation (immunosuppression, rejection, and complications), autosomal polycystic kidney disease (ADPKD) glomerulonephritis, chronic kidney disease after non-renal organ transplantation, hypertension

Emmanuel L. Bravo, M.D.
Phone: 216.444.5829
Specialty interests: Molecular cardiology, cardiovascular biology, endocrine and hypertension research, disorders of the renin-angiotensin-aldosterone system, pheochromocytoma, mineralocorticoid disorders

Sevag Demirjian, M.D.
Phone: 216.445.7585
Specialty interests: Acute renal failure, renal replacement therapy, chronic kidney disease (CKD) epidemiology, genetics in kidney disease, hypertension

Richard Fatica, M.D.
Phone: 216.445.9953
Specialty interests: Fellowship education and training program, kidney and pancreas transplantation, dialysis, hypercoagulable states in chronic kidney disease, calcium and phosphate disorders

Phillip M. Hall, M.D.
Phone: 216.444.6777
Specialty interests: Residency training program, renal disease progression, screening techniques for assessing renal anatomy and function, evaluation of glomerular filtration and renal plasma flow, renal calculi, systemic and regional hemodynamics of hypertension, hypertension in special populations, lupus nephritis
Robert J. Heyka, M.D.
Phone: 216.444.8895
Specialty interests: Acute, continuous renal replacement therapy, hemodialysis, evaluation of adequacy in dialysis modalities, unique aspects of treating hypertension and other disorders in the chronic dialysis patient, renal failure in the ICU patient and those with multiple, severe cardiovascular risk factors.

Joseph V. Nally, Jr., M.D.
Phone: 216.444.8897
Specialty interests: Comprehensive care of the chronic kidney disease (CKD) patient, resistant hypertension, diagnosis and detection of renovascular hypertension, renal physiology and microvasculature, polycystic kidney disease, prevention of renal dysfunction in diabetic patients, screening for cardiovascular disease in end-stage renal disease patients, and medical renal transplantation.

Saul Nurko, M.D.
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Specialty interests: Anemia of chronic kidney disease, iron metabolism in health and disease, acute and chronic renal failure, dialysis, ICU nephrology, transplantation, renal calculi, glomerulonephritis.

Emilio Poggio, M.D.
Phone: 216.444.5383
Specialty interests: Kidney and pancreas transplantation, chronic kidney disease in solid organ transplantation, chronic kidney disease, evaluation of renal function.

Mark A. Pohl, M.D.
Phone: 216.444.6776

Brian Stephany, M.D.
Phone: 216.444.5382
Specialty interests: Chronic kidney disease, general chronic kidney disease after non-renal solid organ transplant, kidney transplantation, glomerular disease.

Emil P. Paganini, M.D., F.A.C.P.
Phone: 216.444.5792
Specialty interests: Hemodialysis, hemofiltration, hemoperfusion, ultrafiltration techniques, membrane pheresis, continuous replacement therapy, membrane effects on cellular function in the uremic patient, physiology of acute and chronic renal failure: prophylactic maneuvers for acute renal failure, geriatric ICU nephrology, osseous and hematological disturbances in chronic renal dysfunction, physiology and hemodynamic effects of r-huepo in patients with renal failure.

Nephrology News is a publication of the Cleveland Clinic Department of Nephrology and Hypertension. It is written for physicians and should be relied upon for medical education purposes only. It does not provide a complete overview of the topics covered, and should not replace a physician’s independent judgment about the appropriateness or risks of a procedure for a given patient.

Martin Schreiber, Jr., M.D.
Chairman, Department of Nephrology and Hypertension

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The Cleveland Clinic Foundation is an independent, not-for-profit, multispecialty academic medical center. It is dedicated to providing quality specialized medical care and includes an outpatient clinic, a hospital with more than 1,000 available beds, an education division and a research institute.

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CKD Clinic Now Available for Comprehensive Care

Cleveland Clinic now offers a multidisciplinary chronic kidney disease (CKD) clinic that provides comprehensive health evaluation, preventive screenings and treatment for patients with this condition. Directed by Joseph Nally, M.D., the new clinic draws on expertise in diabetes management, cardiology, nutrition, patient education and dialysis access.

The clinic accepts referrals for disease evaluation and management of patients at any stage of CKD. At the initial visit, patients undergo a physical examination and e-GFR testing to validate disease stage, as well as a comprehensive cardiovascular evaluation that includes an ECG, a lipid profile and serum cholesterol level. At subsequent visits, a registered dietitian provides nutritional and dietary interventions for renal disease, cardiovascular disease and diabetes as indicated, and dialysis patients are assessed on a regular basis by an access specialist.

The CKD clinic’s emphasis on cardiovascular risk factors derives from evidence of CKD as a powerful, independent predictor for cardiovascular disease. “Knowing that the risk of death from cardiac events is 10 times greater than the risk of dialysis for patients with CKD, cardiovascular risk assessment provides an important diagnostic and prognostic tool for patient management,” Dr. Nally says.

The clinic is structured to integrate research with patient care, and data from patient electronic medical records will be used to develop a CKD database of patient demographics, clinical parameters, treatments and outcomes as the basis for clinical research. A major area of research will be the correlation between CKD and cardiovascular disease and its implications for patient care.

For more information or to refer patients, please contact Dr. Nally at 216.444.8897 or nallyj@ccf.org.

Online Access to Your Patient’s Treatment Progress

Whether you are referring from near or far, our new eCleveland Clinic service, Dr.Connect, can streamline communication from Cleveland Clinic physicians to your office. This new online tool offers you secure access to your patient’s treatment progress at Cleveland Clinic. With one-click convenience, you can track your patient’s care using the secure Dr.Connect Web site. To establish a Dr.Connect account, visit eclevelandclinic.org or e-mail drconnect@ccf.org.

Outcomes Data Available

The latest edition of outcomes data from the Cleveland Clinic Department of Nephrology and Hypertension is available. Our outcomes booklet also offers summary reviews of medical and surgical trends and approaches. Charts, graphs and data illustrate the scope and volume of procedures performed in our department each year. To view outcomes booklets for the Department of Nephrology and Hypertension as well as many other Cleveland Clinic medical and surgical disciplines, visit clevelandclinic.org/quality.