My surgery for kidney cancer

Thomas J. Guzzo, MD, MPH
Chief, Division of Urology
Associate Professor of Surgery (Urology)
University of Pennsylvania Healthy System
Kidneys

Figure 1: The kidneys and urinary system

The kidneys are a pair of organs in the abdomen. The kidneys are the main organs of the urinary system. They filter waste out of blood and make urine. The ureters, bladder, and urethra hold and transport urine before it is released from the body.

https://www.nccn.org/patients/guidelines/kidney/index.html
https://patients.uroweb.org/kidney-cancer/
Kidney cancer

Malignant cell growth (a tumor) in the kidneys
Renal mass vs. kidney cancer vs. renal cell carcinoma (RCC)

- Not all renal masses are cancer, but most of them are (~ 85%)
- Bigger mass = more likely cancer
- Most kidney cancer called RCC

<table>
<thead>
<tr>
<th>Tumor Size (cm)</th>
<th>No. Benign (%)</th>
<th>No. RCC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0–Less than 1.0</td>
<td>37 (46.3)</td>
<td>43 (53.8)</td>
</tr>
<tr>
<td>1.0–Less than 2.0</td>
<td>38 (22.4)</td>
<td>132 (77.7)</td>
</tr>
<tr>
<td>2.0–Less than 3.0</td>
<td>75 (22.0)</td>
<td>266 (78.0)</td>
</tr>
<tr>
<td>3.0–Less than 4.0</td>
<td>71 (19.9)</td>
<td>285 (80.1)</td>
</tr>
<tr>
<td>4.0–Less than 5.0</td>
<td>37 (9.9)</td>
<td>336 (90.1)</td>
</tr>
<tr>
<td>5.0–Less than 6.0</td>
<td>40 (13.0)</td>
<td>267 (87.0)</td>
</tr>
<tr>
<td>6.0–Less than 7.0</td>
<td>11 (4.5)</td>
<td>232 (95.5)</td>
</tr>
<tr>
<td>7.0 or Greater</td>
<td>67 (6.3)</td>
<td>998 (93.7)</td>
</tr>
</tbody>
</table>

Percentages indicate the proportion of tumors in each size category that are benign or RCC, respectively.

J Urol 2003, 170:2217
https://www.nccn.org/patients/guidelines/kidney/index.html
Incidence in United States

- The incidence of kidney cancer has been increasing steadily since the 1970’s (USA)
- Due to more prevalent use of axial imaging (CT/MRI)
- Continue to increase over last decade, about 1% per/year (USA)
Kidney cancer demographics, 2019

- Male: 6th most common cancer diagnosis
- Female: 7th most common cancer diagnosis
- Male > Female 2:1
- Most frequently diagnosed at age 55-74
- Median age at diagnosis: 64
- About 14,770 people (9,820 men and 4,950 women) will die from this disease
Kidney cancer diagnosis

- Most kidney cancers are found by chance during imaging tests for other health problems.
- Majority asymptomatic.
- About 1 in 10 people do experience symptoms like pain in the side of the body, abdominal mass or blood in the urine.
- Bone pain or a persistent cough could be signs that the cancer has spread through the body. This is known as metastatic disease.

https://patients.uroweb.org/kidney-cancer/
Size is important

Figure 5
Kidney tumors are measured in centimeters

A baseball is 7 cm, a golf ball is 4 cm, and a pea is 1 cm.

https://www.nccn.org/patients/guidelines/kidney/index.html
Stages of kidney cancer (TNM staging)

T Stage 1
Tumor ≤7 cm 
confined to kidney

T Stage 2
Tumor >7 cm 
confined to kidney

T Stage 3
Spread into renal vein, 
perirenal fat, or the 
vena cava

T Stage 4
Spread beyond renal 
fascia and into the 
adrenal gland

https://patients.uroweb.org/kidney-cancer/
Stages of kidney cancer (TNM staging)

N0 - No metastasis in lymph node
N1 - Metastasis in regional lymph node
M0 - No distant metastasis
M1 - Distant metastasis

Lung (75%)
Soft tissues (36%)
Bone (20%)
Liver (18%)
Cutaneous sites (8%)
CNS (8%)

https://patients.uroweb.org/kidney-cancer/
## Stages of kidney cancer (TNM staging)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Primary tumor (T)</th>
<th>Regional lymph nodes (N)</th>
<th>Distant metastasis (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>T1: Tumor is 7 cm or smaller and found only in kidney</td>
<td>N0: There is no cancer in nearby lymph nodes</td>
<td>M0: Cancer has not spread to other parts of the body</td>
</tr>
<tr>
<td>Stage II</td>
<td>T2: Tumor is larger than 7 cm and found only in the kidney</td>
<td>N0</td>
<td>M0</td>
</tr>
<tr>
<td>Stage III</td>
<td>T1 or T2: There is cancer (metastasis) in nearby lymph nodes</td>
<td>N0 or N1</td>
<td>M0</td>
</tr>
<tr>
<td></td>
<td>T3: Tumor has grown outside the kidney into major veins and tissues, but not into Gerota’s fascia</td>
<td>N0 or N1</td>
<td>M0</td>
</tr>
<tr>
<td>Stage IV</td>
<td>T4: Tumor has grown beyond Gerota’s fascia</td>
<td>Any N</td>
<td>M0</td>
</tr>
<tr>
<td></td>
<td>Any T</td>
<td>Any N</td>
<td>M1: Cancer has spread to other parts of body (metastasized)</td>
</tr>
</tbody>
</table>
Stage migration

- The greatest increase in incidence has been in small, clinically localized kidney cancers (Stage I [T1N0M0])
- The size of stage I cancers decreases

FIGURE 1. Renal cell carcinoma (RCC) stage distribution by diagnosis year.
### Survival and cancer stages

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Organ-confined (overall)</td>
<td>I</td>
<td>T1-2N0M0</td>
<td>T1-2N0M0</td>
<td>70-90</td>
</tr>
<tr>
<td>≤4.0 cm</td>
<td>I</td>
<td>T1aN0M0</td>
<td>T1aN0M0</td>
<td>90-100</td>
</tr>
<tr>
<td>&gt;4.0 cm to 7.0 cm</td>
<td>I</td>
<td>T1bN0M0</td>
<td>T1bN0M0</td>
<td>80-90</td>
</tr>
<tr>
<td>&gt;7.0 to 10.0 cm</td>
<td>I</td>
<td>T2N0M0</td>
<td>T2aN0M0</td>
<td>65-80</td>
</tr>
<tr>
<td>&gt;10.0 cm</td>
<td>I</td>
<td>T2N0M0</td>
<td>T2bN0M0</td>
<td>50-70</td>
</tr>
<tr>
<td>Invasion of perinephric or renal sinus fat</td>
<td>II</td>
<td>T3aN0M0</td>
<td>T3aN0M0</td>
<td>50-70</td>
</tr>
<tr>
<td>Invasion of renal vein or branches</td>
<td>IIIA</td>
<td>T3bN0M0</td>
<td>T3aN0M0</td>
<td>40-60</td>
</tr>
<tr>
<td>Invasion of IVC below diaphragm</td>
<td>IIIA</td>
<td>T3cN0M0</td>
<td>T3bN0M0</td>
<td>30-50</td>
</tr>
<tr>
<td>Invasion of IVC above diaphragm or invasion of</td>
<td>IIIA</td>
<td>T3cN0M0</td>
<td>T3cN0M0</td>
<td>20-40</td>
</tr>
<tr>
<td>IVC wall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct adrenal involvement</td>
<td>II</td>
<td>T3aN0M0</td>
<td>T4N0M0</td>
<td>0-30</td>
</tr>
<tr>
<td>Locally advanced (invasion beyond Gerota fascia)</td>
<td>IVA</td>
<td>T4N0M0</td>
<td>T4N0M0</td>
<td>0-20</td>
</tr>
<tr>
<td>Lymph node involvement</td>
<td>IIIB</td>
<td>(Any)T(N1-2M0)</td>
<td>(Any)TN1M0</td>
<td>0-20</td>
</tr>
<tr>
<td>Systemic metastases</td>
<td>IVC</td>
<td>(Any)T(Any)NM1</td>
<td>(Any)T(Any)NM1</td>
<td>0-10</td>
</tr>
</tbody>
</table>

IVC, inferior vena cava.

Data from Hafez et al, 1999; Leibovich et al, 2005a; Thompson et al, 2005a; Lane and Kattan, 2008; Campbell et al, 2009; Martinez-Salamanca et al, 2011; and Haddad and Rini, 2012.
Kidney cancer treatment

- **Surgery**
- Active surveillance
- Thermal ablation
- Targeted therapy
- Immunotherapy
- Clinical trials

- Cancer stages
- Cancer complexities
- General health
- Your preferences for treatment

Surgery is the main treatment for the majority of kidney cancers, with the goal of removing the tumor and preserving normal kidney function.
# Surgical treatment

<table>
<thead>
<tr>
<th>Stage</th>
<th>Surgery</th>
<th>Approach</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Nephron-sparing surgery</td>
<td>Open, Laparoscopic</td>
<td>Recommended standard</td>
</tr>
<tr>
<td></td>
<td>Radical nephrectomy</td>
<td>Robotz</td>
<td>Optional in experienced centres</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In patients not suitable for nephron-sparing surgery</td>
</tr>
<tr>
<td>T2</td>
<td>Radical nephrectomy</td>
<td>Laparoscopic/Robotic</td>
<td>Recommended standard</td>
</tr>
<tr>
<td></td>
<td>Nephron-sparing surgery</td>
<td></td>
<td>Recommended in selected patients in experienced centres</td>
</tr>
<tr>
<td>T3, T4</td>
<td>Radical nephrectomy</td>
<td>Open, Laparoscopic</td>
<td>Recommended standard for most patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Robotz</td>
<td>Feasible in selected patients</td>
</tr>
</tbody>
</table>

**Images**

- **Radical nephrectomy**
- **Partial nephrectomy**
My surgery for kidney cancer

**Goals**

- **Oncologic outcomes**
  - Cancer removal is still priority

- **Renal functional outcomes**
  - Nephron-sparing whenever possible

- **Morbidity**
  - Minimally-invasive whenever possible

Patients with localized RCC typically do not die of RCC
Increased emphasis on functional aspects
Functional outcomes for survivorship in most patients
My experiences

- Medical School: Temple University School of Medicine
- Residency (Urology): Hospital of the University of Pennsylvania
- Fellowship (Urologic Oncology): Johns Hopkins Hospital
- Faculty at Penn Medicine since 2009
- Focusing on surgical treatment, especially minimally-invasive surgery for kidney, prostate, bladder, testicular and other urologic cancers

- Open surgery
- Laparoscopic surgery
- Robotic surgery

Unbiased opinion
Small kidney tumors

Management of Small Kidney Tumors
Tumors in the kidney measuring 4 cm or less are unlikely to rapidly grow or spread to other parts of the body.

Treatment options
- **Active surveillance**
  Regular observation of the tumor to determine if it grows

- **Partial nephrectomy**
  Surgical removal of the tumor and surrounding healthy tissue
  - **Incision around the tumor**
  - **Kidney after surgery**

- **Percutaneous ablation**
  Freezing (cryoablation) or heating (radiofrequency ablation) of the tumor
  - A probe is guided through the skin into the tumor using ultrasound, CT, or MRI guidance.

- **Radical nephrectomy**
  Surgical removal of the entire kidney, nearby adrenal gland, and lymph nodes

Robot-assisted partial nephrectomy
Robot-assisted partial nephrectomy (RAPN)

Systematic Review and Meta-analysis of Comparative Studies Reporting Perioperative Outcomes of Robot-Assisted Partial Nephrectomy Versus Open Partial Nephrectomy

Leilei Xia, MD,1 Xianjin Wang, MD,2 Tianyuan Xu, MD,2 and Thomas J. Guzzo, MD, MPH1

- Equivalent oncologic and functional outcomes
- Less blood loss
- Fewer complications
- Reduced pain and discomfort
- Shorter hospitalization
- Faster recovery time and return to normal activities
- Smaller incisions, resulting in reduced risk of infection
- Better cosmetic appearance

https://www.uchealth.com/services/robotic-surgery/patient-information/benefits/
J Endourol. 2017 Sep;31(9):893-909
What are the advantages

- Immersive high-definition 3-D visualization
- Enhanced dexterity, fully articulating instruments
- Greater precision, intuitive computer-enhanced motion control

Surgeons can perform delicate and complex procedures that may have been difficult or impossible with other methods, such as partial nephrectomy
When performing robotic surgery using the da Vinci Surgical System:

- The surgeon works from a computer console in the operating room, controlling miniaturized instruments mounted on three robotic arms to make tiny incisions in the patient.
- The surgeon looks through a 3-D camera attached to a fourth robotic arm, which magnifies the surgical site.
- The surgeon’s hand, wrist and finger movements are transmitted through the computer console to the instruments attached to the robot’s arms. The mimicked movements have the same range of motion as the surgeon allowing maximum control.
- The surgical team supervises the robot at the patient’s bedside.
Robot-assisted partial nephrectomy

No cancer recurrence since 2016
Intraoperative imaging at Penn

Mission Statement: To improve the cancer care of surgery patients through intraoperative molecular imaging techniques

13 Surgeons (Thoracic, Urology, Neurosurgery, Surg Onc, Breast, ENT, Gyn Onc), 2 Staff PhDs, 10+ Active Clinical Trials, Over 500 patients enrolled
Intraoperative imaging at Penn

**Intraoperative Molecular Diagnostic Imaging Can Identify Renal Cell Carcinoma**

Thomas J. Guzzo, Jack Jiang, Jane Keating, Elizabeth DeJesus, Ryan Judy, Shuming Nie, Philip Low, Priti Lal and Sunil Singhal

From the Departments of Surgery (TJ, JJ, JD, RP) and Pathology (PL), Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, Departments of Biomedical Engineering and Chemistry, Emory University (BSN), Atlanta, Georgia, and Department of Chemistry (PL), Purdue University, West Lafayette, Indiana

**Near-infrared Intraoperative Molecular Imaging Can Identify Metastatic Lymph Nodes in Prostate Cancer**

Leilei Xia, Ryan Zeh, Jack Mizelle, Andrew Newton, Jarrod Predina, Shuming Nie, Sunil Singhal, and Thomas J. Guzzo

**Intraoperative Molecular Imaging for Post-Chemotherapy Robot-Assisted Laparoscopic Resection of Seminoma Metastasis: A Case Report**

Leilei Xia, Ollin G. Venegas, Jarrod D. Predina, Sunil Singhal, Thomas J. Guzzo

J Urol. 2016 Mar;195(3):748-55
Near-Infrared Fluorescence Imaging with Intraoperative Administration of Indocyanine Green for Robotic Partial Nephrectomy

Marc A. Bjerlin, Tyler R. McClintock, Michael D. Stileman

Fig 1 NIF imaging with ICG to facilitate optimization of renal tumor localization. Renal mass seen under white light (a) and under NIF imaging with ICG demonstrating a hypofluorescent tumor adjacent to bright green normal renal parenchyma (b)

Indocyanine green (ICG)
Intraoperative imaging in RAPN

Folate receptor targeted dye OTL38
Laparoscopic/robotic radical nephrectomy

- Mostly for large (>7 cm) and/or endophytic tumors that partial nephrectomy would be oncologically unsafe but can still be done in a minimally invasive manner
- Robot is better than conventional laparoscopy
Open radical nephrectomy with or without thrombectomy

- For very large tumors with or without tumor thrombus in renal vein or inferior vena cava (IVC)
- Cancer control is priority, complete resection of the tumor and thrombectomy allow for the best chance of cure
- Sometimes involves other surgical teams
- High volume institution for RCC IVC thrombectomy
Multidisciplinary surgical team

Surgical Oncology

Anesthesiology and Critical Care

Cardiac Surgery

Urologic Oncology

Vascular Surgery
Cytoreductive nephrectomy

- Established management options for selected individuals with metastatic renal cell cancer (mRCC)
- Careful patient selection with multidisciplinary input is essential
My surgery for kidney cancer

- Surgery is the main treatment for the majority of kidney cancers
- Most small kidney tumors/cancers can be surgically treated with robot-assisted partial nephrectomy
- Some larger tumors/cancers can still be done through minimally invasive approach, either partial nephrectomy or radical nephrectomy
- Open radical nephrectomy with or without thrombectomy are reserved for very large/complex cancers, multidisciplinary surgical team is often needed
- Cytoreductive nephrectomy is still recommended for certain patients

https://patients.uroweb.org/kidney-cancer/
Recommendations and References

https://www.nccn.org/patients/guidelines/kidney/index.html
https://patients.uroweb.org/kidney-cancer/
Thank you

Hospital of the University of Pennsylvania
Perelman Center for Advanced Medicine