Contrast Nephropathy

58th ERA-EDTA Congress, June 5-8 2021

- Masoud Khosravi, M.D., Nephrologist
- Guilin University of Medical Sciences
- 000709

- 01 Oct 21

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Changes in the landscape of contrast nephropathy

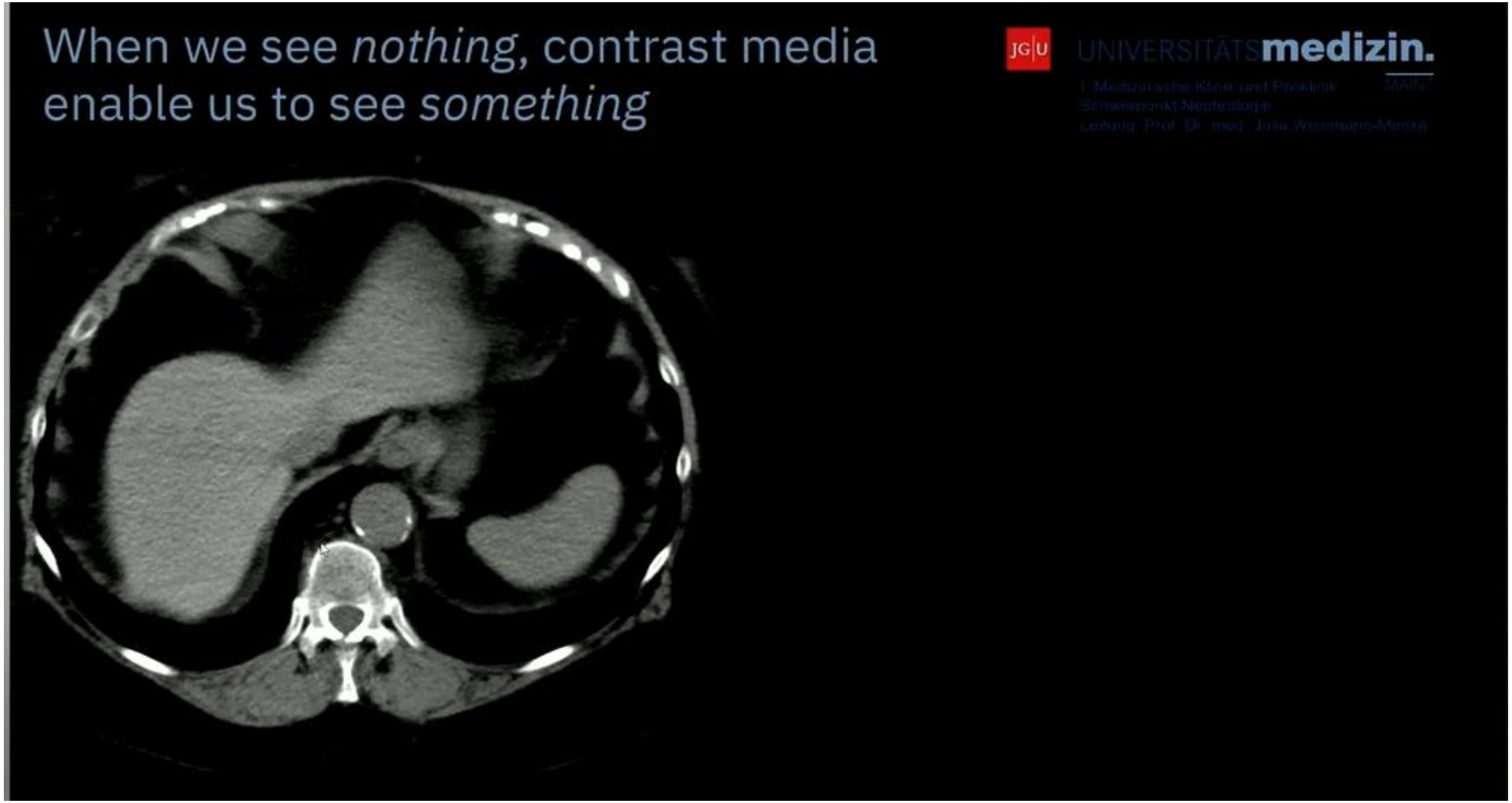
PD Dr. med. Daniel Kraus
Attending physician, Division of Nephrology
Ist Department of Medicine
University Medical Center, Mainz, Germany

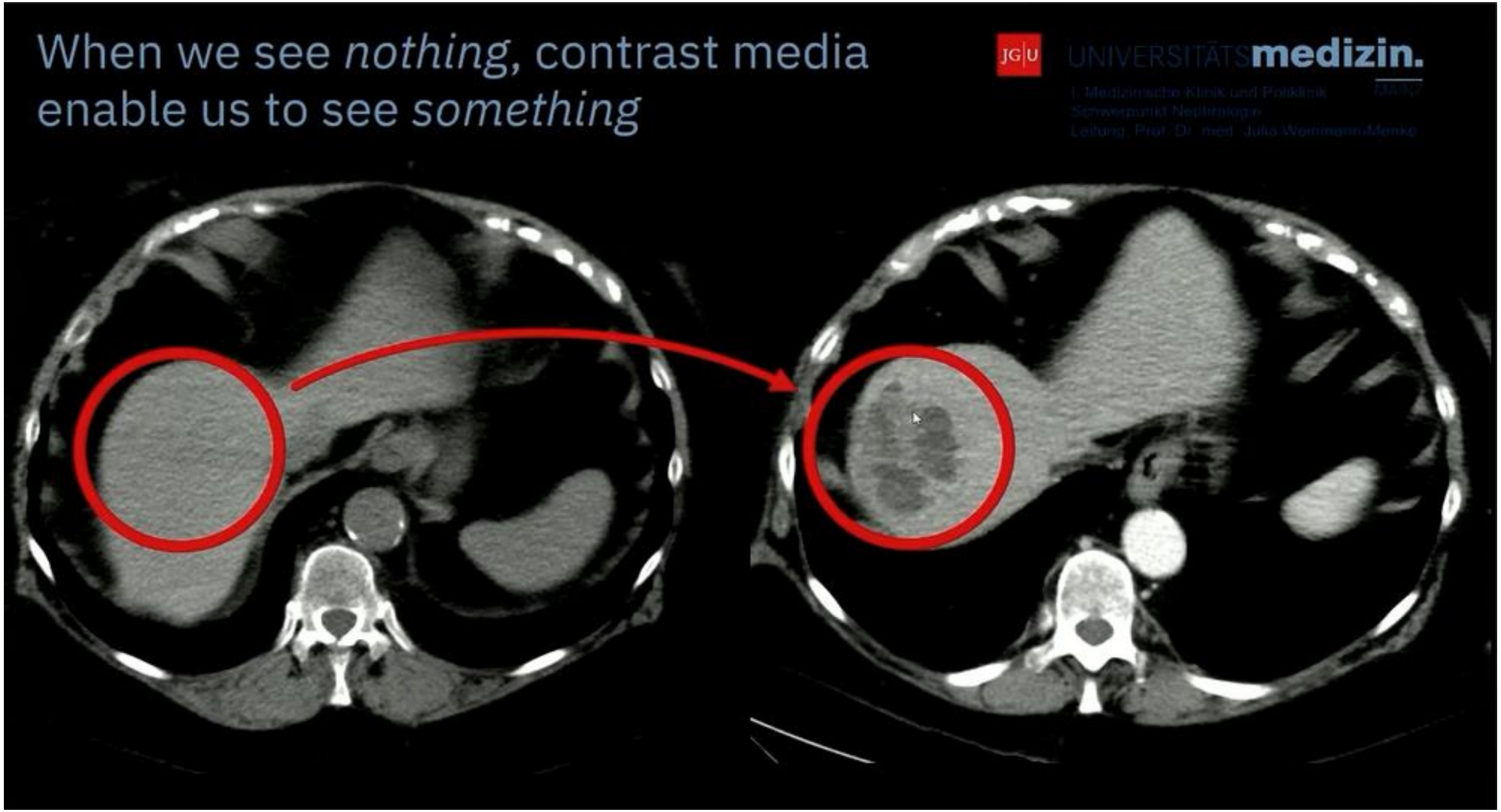
Daniel Kraus
Changes in the landscape of contrast nephropathy

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

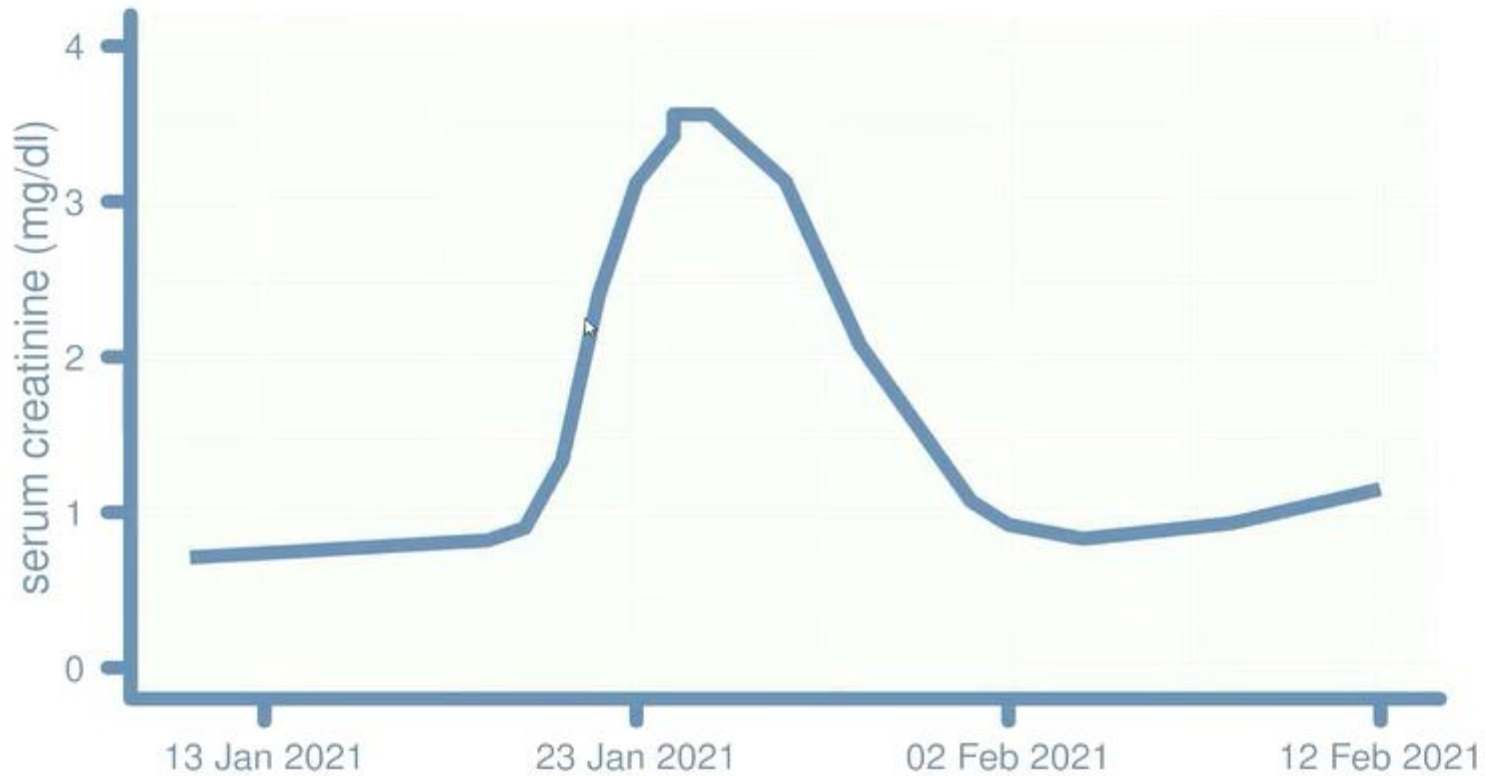
I have no conflicts of interest to declare

When we see *nothing*, contrast media enable us to see *something*

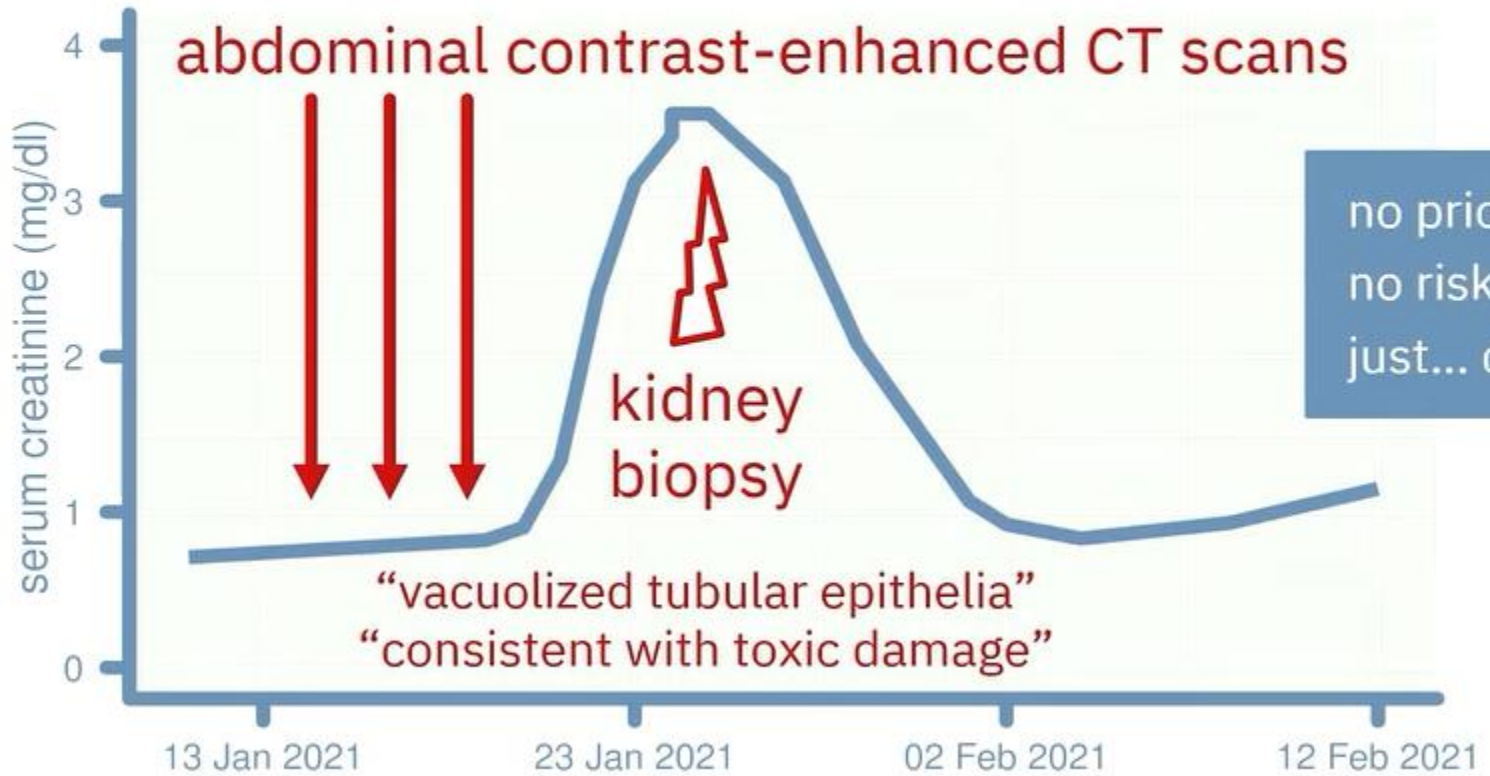



When we see *nothing*, contrast media enable us to see *something*
JG|U
UNIVERSITÄTSmedizin.

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

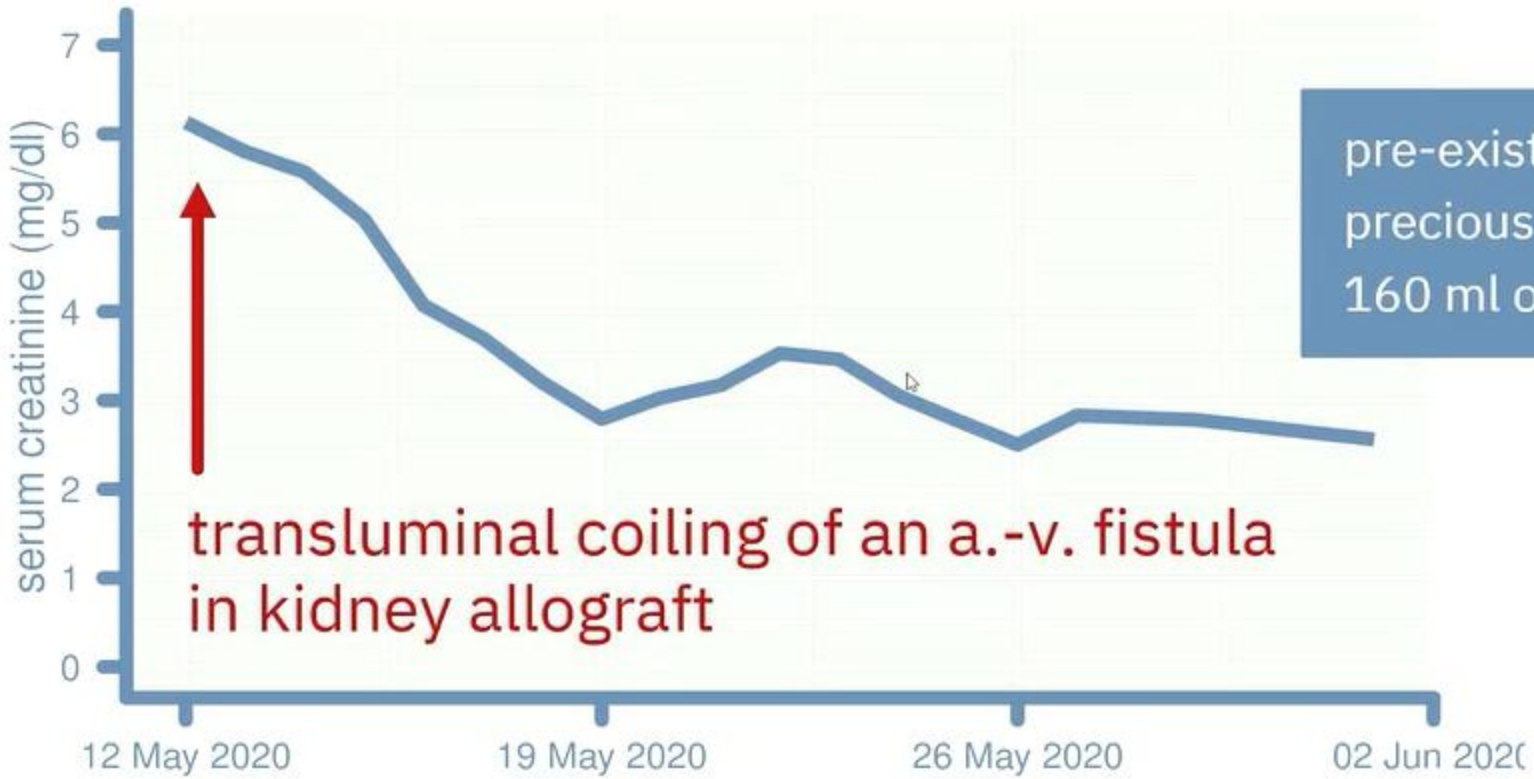


UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



no prior kidney disease
no risk factors
just… contrast exposure

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

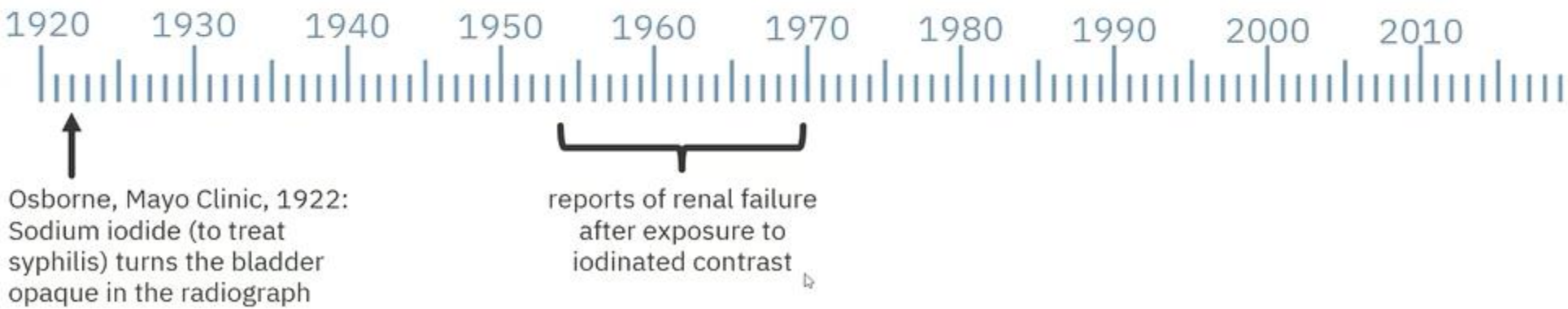


transluminal coiling of an a.-v. fistula
in kidney allograft

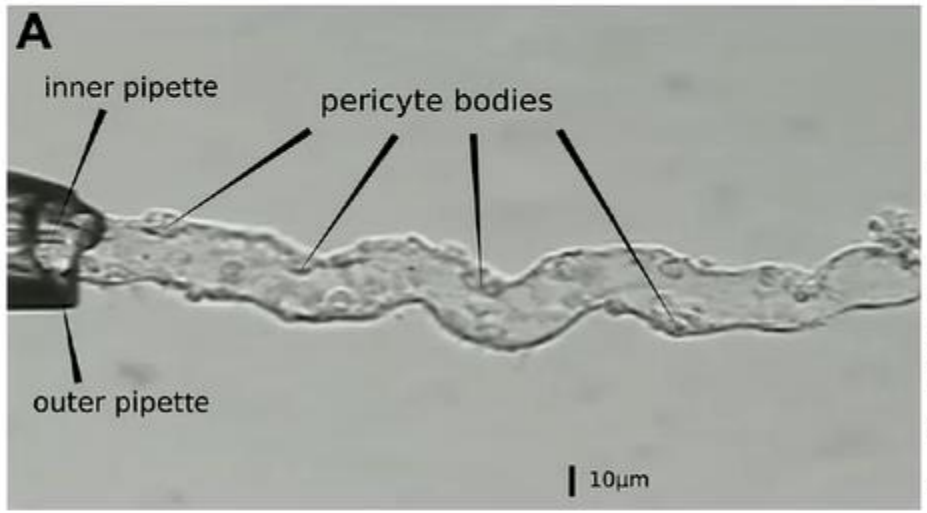
pre-existing AKI
precious allograft
160 ml of i.a. contrast

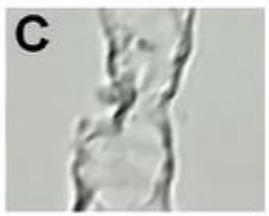
A very short history
of post-contrast acute kidney injury (PC-AKI)

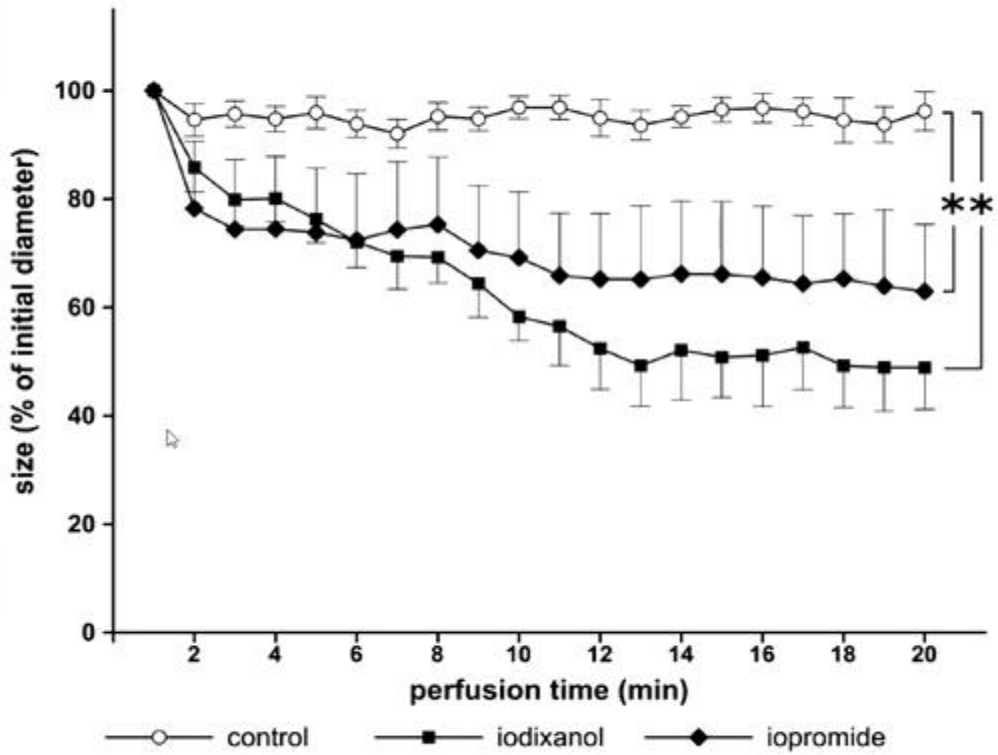
UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke







Sendeski *et al.*, Invest. Radiol. 2010; Sendeski *et al.*, Am J Physiol 2012

A very short history
of post-contrast acute kidney injury (PC-AKI)

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

none of these and other prevention studies included a control group *without* contrast exposure

PRESERVE (2018)
ACC vs. placebo
0.9% NaCl vs. bicarbonate

AMACING (2017)
0.9% NaCl
vs. nothing

ACT (2011)
acetylcysteine
vs. placebo

Osborne, Mayo Clinic, 1922: Sodium iodide (to treat syphilis) turns the bladder opaque in the radiograph

reports of renal failure after exposure to iodinated contrast

Mehran Risk Score

Clinical epidemiology of post-contrast AKI
Only very few controlled studies

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke


Risk of Nephropathy after Intravenous Administration of Contrast Material: A Critical Literature Analysis¹

systematic PubMed query
3081 articles
40 (1.3%) with intravenous contrast
2 controlled studies

Rao & Newhouse, Radiology 2006

Two prospective, controlled studies

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Cramer *et al.*, Arch Int Med 1985

- two centers (Montreal, CA)
- non-randomized CT with/without CM
- AKI with CM: 4/193 (2.1%)
- AKI without CM: 3/233 (1.3%)
- p = 0.53
- "high-risk cohort" (SCr > 1.5 mg/dl)
  - AKI with CM: 0/19 (0%)
  - AKI without CM: 2/46 (4.3%)

Heller *et al.*, Med J Aus 1991

- single center (Newcastle, NSW, AUS)
- randomized CT with/without CM
- AKI with CM: 12/292 (4.1%)
- AKI without CM: 16/405 (4.0%)
- OR 1.06 (95% CI: 0.5-2.3)

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

We will never get a large RCT on this topic

Propensity score matching

The next best thing if you can't have RCTs

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

- retrospective, single center
- n = 251,728
- risk groups:
  - SCr < 1.5 mg/dl: n = 102,590
  - 1.5 ≤ SCr < 2: n = 11,357
  - SCr ≥ 2 mg/dl: n = 2,747
- incidence of AKI independent of CM exposure
- special feature: counterfactual analysis
  - patients with CT + and – CM
  - patients serve as their own controls

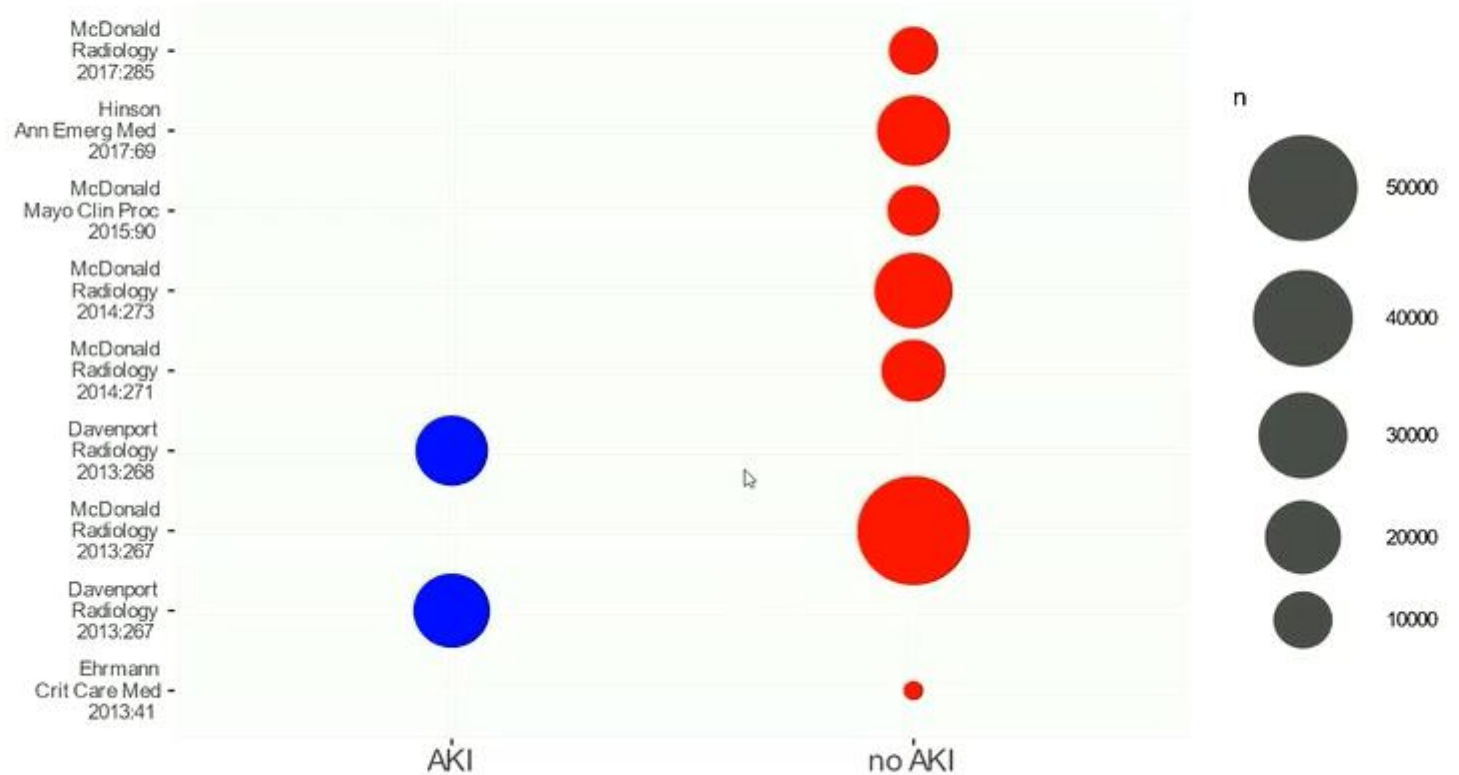
Risk of AKI after CT Scan in the Counterfactual Data Set

Variable	AKI
Group	
Contrast enhanced*	194/4265 (4.5)
Unenhanced*	209/4265 (4.9)
Unadjusted analysis†	
Odds ratio‡	0.92 (0.75, 1.13)
P value	.46
Adjusted analysis§	
Odds ratio‡	0.97 (0.79, 1.18)
P value	.65

McDonald *et al.*, Radiology 2013

Studies with propensity-score matching
i.v. contrast

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



Daniel Kraus, unpublished

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

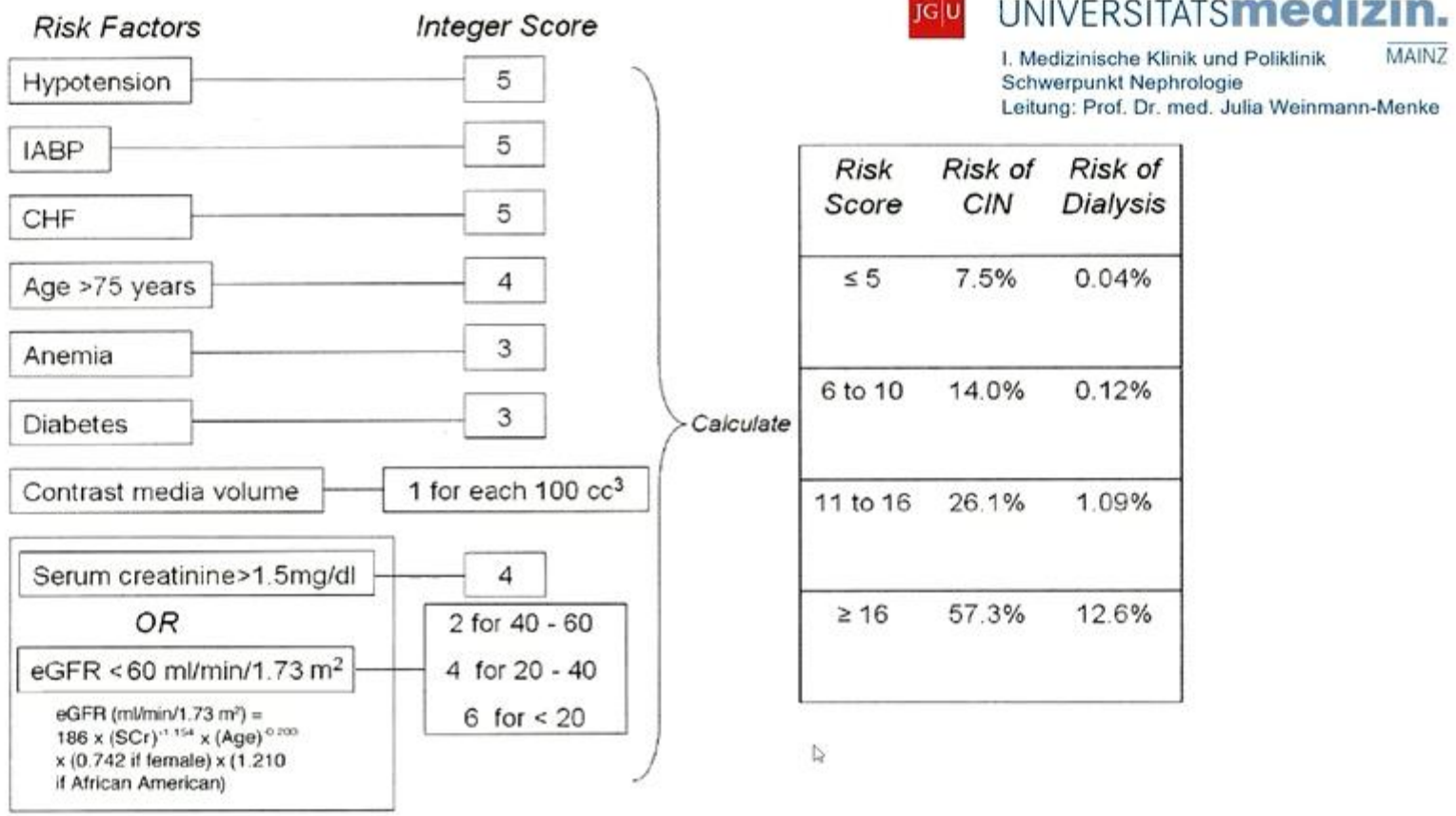


Figure 5. Scheme to define contrast-induced nephropathy (CIN) risk score. Anemia = baseline hematocrit value <39% for men and <36% for women; CHF = congestive heart failure class III/IV by New York Heart Association classification and/or history of pulmonary edema; eGFR = estimated glomerular filtration rate; hypotension = systolic blood pressure <80 mm Hg for at least 1 h requiring inotropic support with medications or intra-aortic balloon pump (IABP) within 24 h periprocedurally.

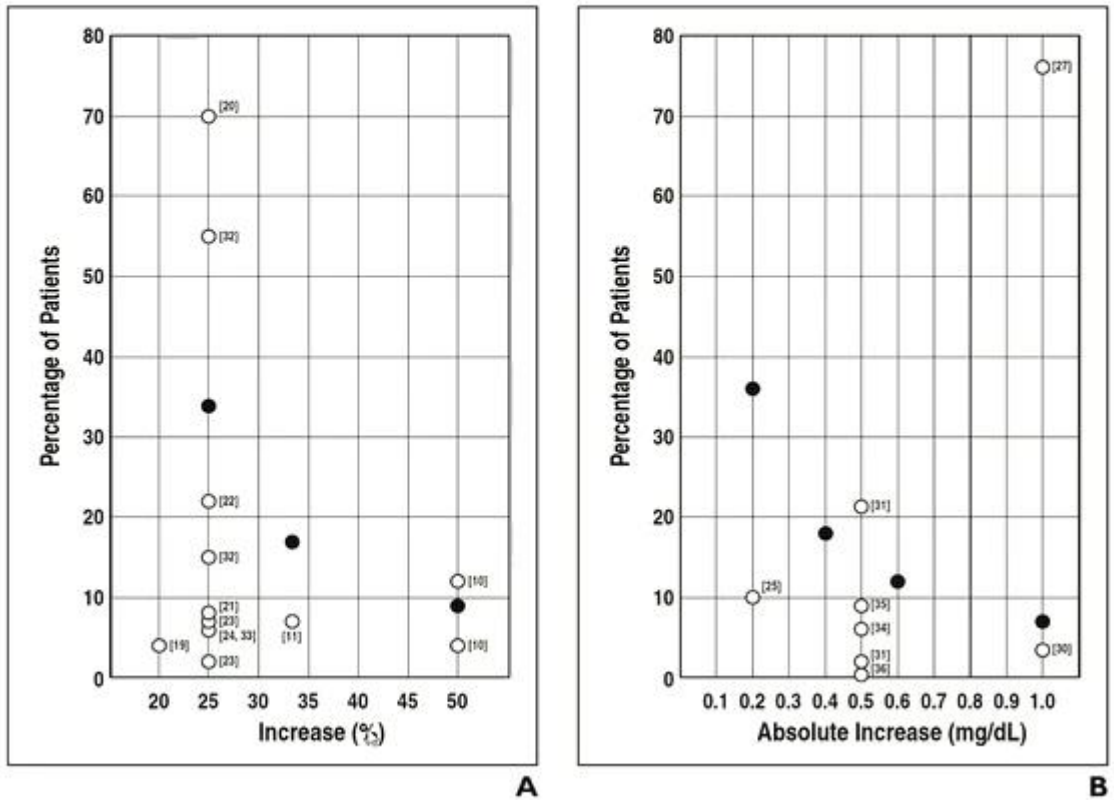
Mehran *et al.*, J Am Coll Cardiol 2004

These are all general risk factors for kidney failure

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Increases in creatinine levels are commonplace in hospitalized patients even without contrast

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



Clinical Data Warehouse
n = 32,161
SCr measured 5 days in a row
no contrast exposure

● no CM (current study)
○ CM (published incidences)

Newhouse *et al.*, Am J Radiol 2008

Does contrast reduce residual kidney function?
Hemodialysis patients

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Table 1 Daily urine volumes (V, ml)

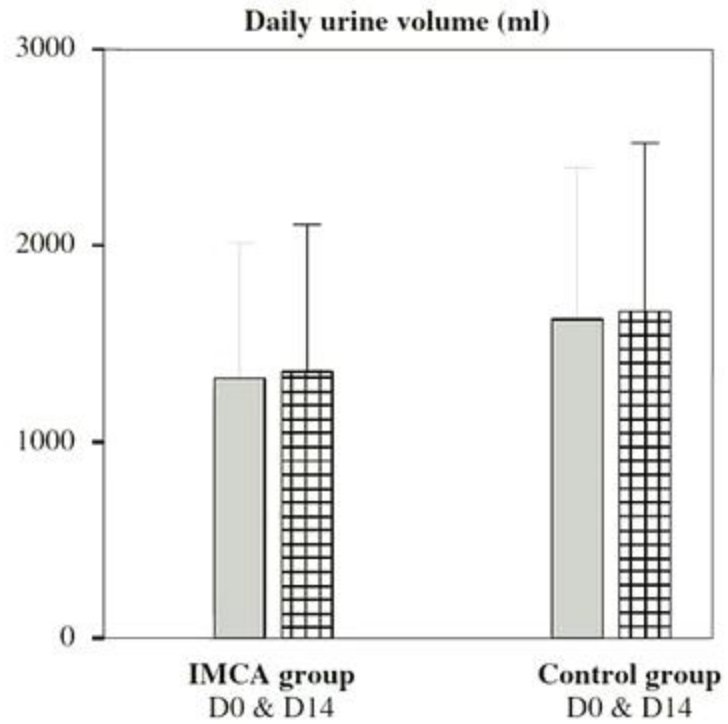
Volume	Group A, contrast media n = 42			Group B, control n = 45		
↓ month	Median	Range	Quartile (25th–75th percentile)	Median	Range	Quartile (25th–75th percentile)
1	1500	500–4500	987–2000	1400	500–3500	1000–1750
2	1475	500–3220	987–2000	1200	500–2500	960–1500
3	1500	500–3800	937–2000	1100	500–2100	875–1500
4	1150	500–3500	850–1925	1000	500–2100	780–1575
5	1300	500–2420	700–1775	1000	500–2300	725–1400
6	1225	500–2100	737–1662	900	500–2400	700–1200

single center, prospective, controlled, not randomized
33x angioplasty, 6x thrombectomy, 3x angiography
ø 99 (60-180) ml iodixanol, no pre-hydration strategy
p = 0.855 (Kolmogorow-Smirnow)

Janousek *et al.*, Cardiovasc Intervent Radiol 2010

Does contrast reduce residual kidney function?
Peritoneal dialysis patients

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



single center, prospective, controlled
n = 36 with + 36 without contrast exposure
~ 50% diabetics
17x coronary, 10x peripheral angiography
4x abdominal, 5x aortic CT angiography
ø 104 ± 55 ml iodixanol
hydration with 1 l 0.9% NaCl i.v.

IMCA (typo) = ICMA = iodinated contrast media administration

Moranne *et al.*, Nephrol Dial Transpl 2006

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

What do the societies say?

American College of Radiology
ACR

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

"CIN is a real, albeit rare, entity."

"Failure to diagnose an important clinical entity carries its own risk."

"The risk of clinically relevant renal dysfunction is very low in many situations. However, patients with AKI or severe chronic kidney disease are considered at risk for CIN."

CIN, contrast-induced nephropathy

European Society of Urogenital Radiology
ESUR

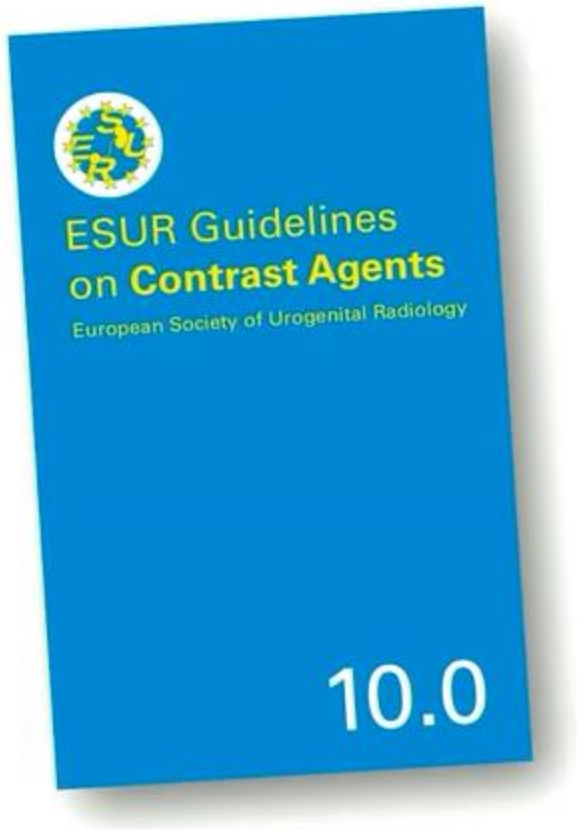
JG|U UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

"When properly corrected
for the many other possible causes of AKI
in patients with chronic kidney disease,
the risk of CI-AKI [...] is low."

van der Moolen *et al.*, Eur Radiol 2018

European Society of Urogenital Radiology
ESUR

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke



"At-risk patients –
Consider an alternative imaging method
not using iodine-based contrast media."

van der Moolen *et al.*, Eur Radiol 2018

Position statement of the German Society of Nephrology (DGfN) and the German Society of Cardiology (DGK) – July 2020

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke


Der Kardiologe

Kontrastmittelinduzierte akute Nierenschädigung – Konsensuspapier der Arbeitsgemeinschaft „Herz – Niere" der Deutschen Gesellschaft für Kardiologie – Herz- und Kreislaufforschung e.V. und der Deutschen Gesellschaft für Nephrologie e.V.

Präambel

"consider alternative diagnostic procedure if eGFR < 30"

"do not delay imaging in medical urgency or if the alternatives are not equivalent"

(translation by me)

Latus *et al.*, Der Kardiologe 2020

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

But what happens if we just don't give CM?

“Renalism”

“Renalism”: Inappropriately Low Rates of Coronary Angiography in Elderly Individuals with Renal Insufficiency

GLENN M. CHERTOW,* SHARON-LISE T. NORMAND,†‡ and BARBARA J. MCNEIL§

*Division of Nephrology, Department of Medicine, †Department of Health Care Policy, Harvard Medical School, Boston, Massachusetts, and ‡Department of Biostatistics, §Harvard School of Public Health, Boston, Massachusetts

JG|U UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Renalism: “alteration in practice because of an aversion to the risk of radiocontrast-associated nephrotoxicity”

is inappropriate.

Chertow *et al.*, J Am Soc Nephrol 2004

“Renalism” in 2021

ARTICLE IN PRESS

Impact of Chronic Kidney Disease on Revascularization and Outcomes in Patients with ST-Elevation Myocardial Infarction

Hemang B. Panchal, MD, MPH[a], Shimin Zheng, PhD[b], Kalpit Devani, MD[c], Christopher J White, MD[d,e], Edward F Lesnar, MPH[f], Debabrata Mukherjee, MD, MS[g], Mamas Mamas, MD[h,i], Subhash Banerjee, MD[j], Deepak L. Bhatt, MD, MPH[k], Hani Jneid, MD[l], Habib Samady, MD[m], Roxana Mehran[n], Shahyar M Gharacholou, MD[o], and Tamir K Paul, MD, PhD[p,*]

Chronic kidney disease (CKD) in patients with ST-elevation myocardial infarction (STEMI) is associated with worse outcomes. We assessed the impact of CKD on guideline-directed coronary revascularization and outcomes among STEMI patients. The Nationwide Inpatient Sample dataset from 2012-2014 was used to identify patients with STEMI using International Classification of Diseases, Ninth Revision, Clinical Modification codes. Patients were categorized as non-CKD, CKD without dialysis, and CKD with dialysis (CKD-HD). Outcomes were revascularization, death and acute renal failure requiring dialysis (ARFD). A total of 534,845 were included (88.9% non-CKD; 9.6% CKD without dialysis, and 1.5% CKD-HD). PCI was performed in 77.4% non-CKD, 56.2% CKD without dialysis, and 48% CKD-HD patients (p < 0.0001). In-hospital mortality and ARFD were significantly higher in CKD patients (16.5% and 40.6%) compared with non-CKD patients (7.12% and 7.17%) (p < 0.0001). In-hospital mortality was significantly lower in patients treated revascularization compared with patients treated medically (non-CKD: adjusted odds ratio (aOR) 0.280, p < 0.0001; CKD without dialysis: aOR 0.39, p < 0.0001; CKD-HD: aOR 0.48, p < 0.0001). CKD was associated with higher length of hospital stay and cost (5.86 ± 13.97, 7.57 ± 26.06 and 3.99 ± 11.09 days; p < 0.0001; $25,696 ± $63,024, $35,666 ± $104,940 and $23,264 ± $49,712; p < 0.0001 in non-CKD, CKD without dialysis and CKD-HD patients respectively). In conclusion, CKD patients with STEMI receive significantly less PCI compared with patients without CKD. Coronary revascularization for STEMI in CKD patients was associated with lower mortality compared to medical management. The presence of CKD in patients with STEMI is associated with higher mortality and ARFD, prolonged hospital stay and higher hospital cost. © 2021 Elsevier Inc. All rights reserved. (Am J Cardiol 2021;00:1–9)

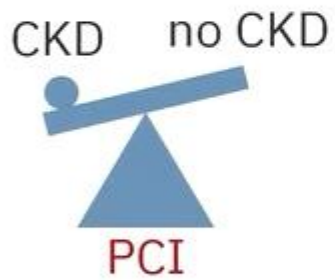
[a]Florida Heart Center P.A. (Fort St Lucie, Florida [b]Department of Biostatistics, East Tennessee State University, Johnson City, Tennessee [c]Department of Medicine, East Tennessee State University, Johnson City, Tennessee, [d]Department of Cardiovascular Diseases, The Ochsner Clinical School, University of Queensland, Australia, [e]The John Ochsner Heart & Vascular Institute, Ochsner Medical Center, New Orleans, Los Angeles, [f]Department of Health Services Management and Policy, East Tennessee State University, Johnson City, Tennessee, [g]Division of Cardiology, Department of Internal Medicine, Texas Tech University, El Paso, Texas, [h]Keele Cardiovascular Research Group, Keele University, Stoke on Trent, United Kingdom, [i]Dept of Cardiology, Thomas Jefferson University, Philadelphia, [k]VA North Texas Health Care System, University of Texas Southwestern Medical Center at Dallas, Texas, [l]Brigham and Women's Hospital Heart & Vascular Center, Harvard Medical School, Boston, Massachusetts, [m]Division of Cardiology, Emory University School of Medicine, Atlanta, Georgia, [n]The Cardiovascular Institute, Icahn School of Medicine at Mount Sinai, New York, New York, and [o]Mayo Clinic Cardiovascular Medicine, Jacksonville, Florida. Manuscript received December 17, 2020; revised manuscript received and accepted March 26, 2021

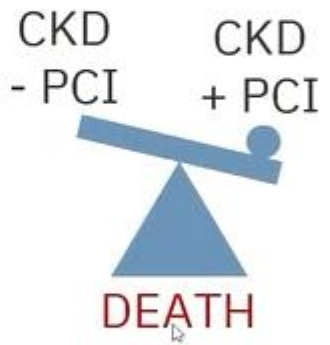
Grant support: This research did not receive any financial or grant support.

*Corresponding author: Tel: 423-979-6100; fax: 423-979-6136.
E-mail address: [redacted]@[redacted].com (T.K. Paul).

https://doi.org/10.1016/j.amjcard.2021.03.035

Chronic kidney disease (CKD) is a common comorbidity among patients presenting with ST elevation myocardial infarction (STEMI) and primary percutaneous coronary intervention (PCI) is the standard of care for STEMI patients. Several studies have shown that patients with CKD who present with STEMI do not receive guideline-directed interventions compared to patients with normal renal function.[1–3] A project that linked the US Renal Data System database with the National Registry of Myocardial Infarction 3 showed that the patients on dialysis more often experienced pathological delays in the reassignment of acute myocardial infarction due to less suspicion of acute coronary syndrome and lower percentage of dialysis patients having chest pain as compared to non-dialysis patients.[4] Moreover, patients with renal dysfunction who presented with STEMI or left bundle branch block received less reperfusion therapy compared to those with normal renal function.[5] Studies have shown that patients with moderate to severe CKD who presented with STEMI have significantly higher in-hospital mortality compared to patients with normal renal function. Higher mortality in CKD patients presenting with STEMI could be secondary to suboptimal care or additions to comorbidities. The primary objective of this

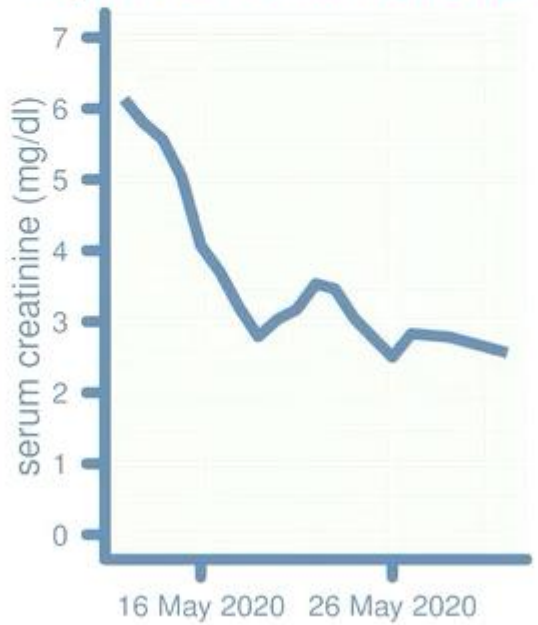




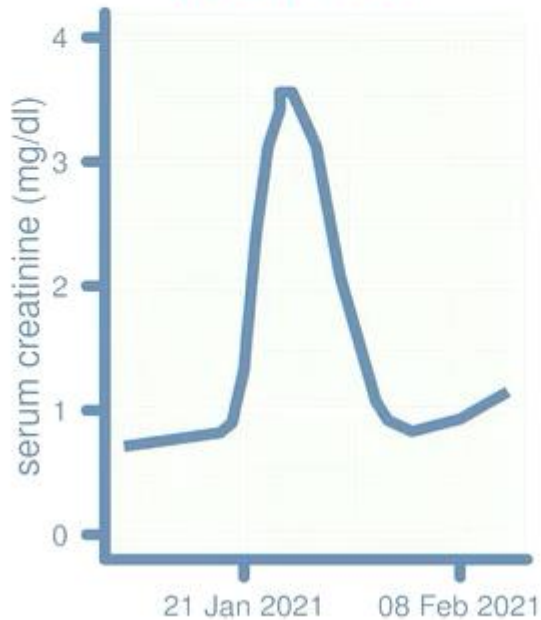
Panchal *et al.*, Am J Cardiol 2021 (May 15)

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

"high risk" for PC-AKI
intraarterial contrast
improved renal function

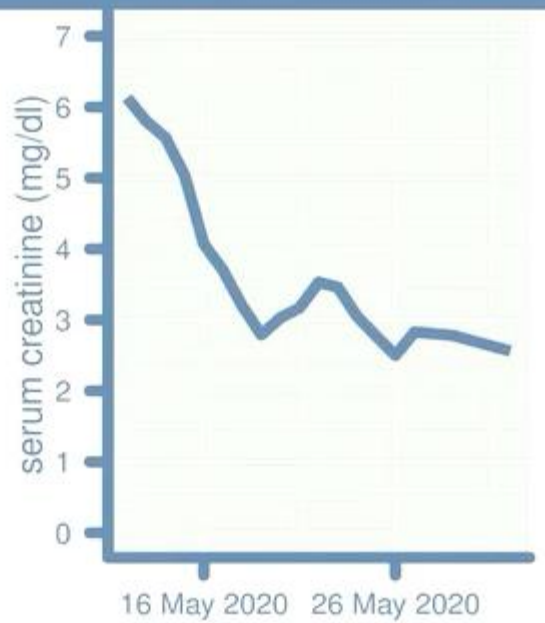


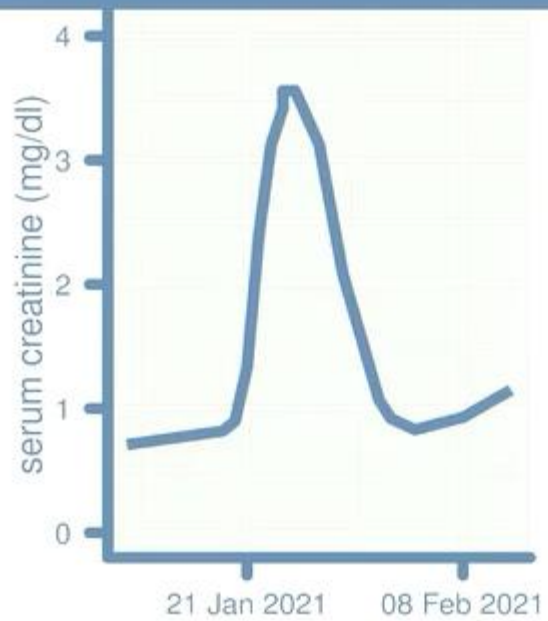
low risk for PC-AKI
3x intravenous contrast
severe AKI

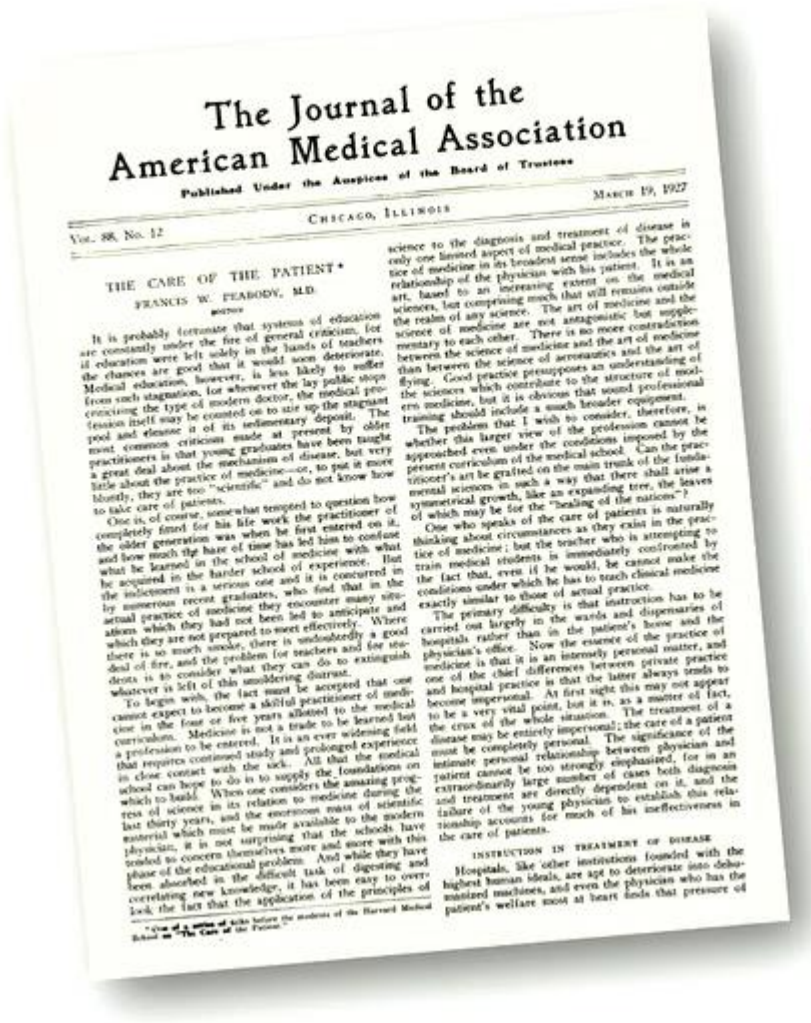


UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

it's not *deterministic*
it's *idiosyncratic*







The Journal of the American Medical Association

Published Under the Auspices of the Board of Trustees

Vol. 88, No. 12 — Chicago, Illinois — March 19, 1927

THE CARE OF THE PATIENT *

FRANCIS W. PEABODY, M.D.

BOSTON

It is probably fortunate that systems of education are constantly under the fire of general criticism, for if education were left solely in the hands of teachers the chances are good that it would soon deteriorate. Medical education, however, is less likely to suffer from such stagnation, for whenever the lay public stops criticizing the type of modern doctor, the medical profession itself may be counted on to stir up the stagnant pool and eliminate it of its sedimentary deposit. The most common criticism made at present by older practitioners is that young graduates have been taught a great deal about the mechanism of disease, but very little about the practice of medicine—or, to put it more bluntly, they are too "scientific" and do not know how to take care of patients.

One is, of course, somewhat tempted to question how completely fitted for his life work the practitioner of the older generation was when he first entered on it, and how much the haze of time has led him to confuse what he learned in the school of medicine with what he acquired in the harder school of experience. But the indictment is a serious one and it is concurred in by numerous recent graduates, who find that in the actual practice of medicine they encounter many situations which they had not been led to anticipate and which they are not prepared to meet effectively. Where there is so much smoke, there is undoubtedly a good deal of fire, and the problem for teachers and for students is to consider what they can do to extinguish whatever is left of this smouldering distrust.

To begin with, the fact must be accepted that one cannot expect to become a skilful practitioner of medicine in the four or five years allotted to the medical curriculum. Medicine is not a trade to be learned but a profession to be entered. It is an ever widening field that requires continued study and prolonged experience in close contact with the sick. All that the medical school can hope to do is to supply the foundations on which to build. When one considers the amazing progress of science in its relation to medicine during the last thirty years, and the enormous mass of scientific material which must be made available to the modern physician, it is not surprising that the schools have tended to concern themselves more and more with this phase of the educational problem. And while they have been absorbed in the difficult task of digesting and correlating new knowledge, it has been easy to overlook the fact that the application of the principles of science to the diagnosis and treatment of disease is only one limited aspect of medical practice. The practice of medicine in its broadest sense includes the whole relationship of the physician with his patient. It is an art, based to an increasing extent on the medical sciences, but comprising much that still remains outside the realm of any science. The art of medicine and the science of medicine are not antagonistic but supplementary to each other. There is no more contradiction between the science of medicine and the art of medicine than between the science of aeronautics and the art of flying. Good practice presupposes an understanding of the sciences which contribute to the structure of modern medicine, but it is obvious that sound professional training should include a much broader equipment.

The problem that I wish to consider, therefore, is whether this larger view of the profession cannot be approached even under the conditions imposed by the present curriculum of the medical school. Can the practitioner's art be grafted on the main trunk of the fundamental sciences in such a way that there shall arise a symmetrical growth, like an expanding tree, the leaves of which may be for the "healing of the nations"?

One who speaks of the care of patients is naturally thinking about circumstances as they exist in the practice of medicine; but the teacher who is attempting to train medical students is immediately confronted by the fact that, even if he would, he cannot make the conditions under which he has to teach clinical medicine exactly similar to those of actual practice.

The primary difficulty is that instruction has to be carried out largely in the wards and dispensaries of hospitals rather than in the patient's home and the physician's office. Now the essence of the practice of medicine is that it is an intensely personal matter, and one of the chief differences between private practice and hospital practice is that the latter always tends to become impersonal. At first sight this may not appear to be a very vital point, but it is, as a matter of fact, the crux of the whole situation. The treatment of a disease may be entirely impersonal; the care of a patient must be completely personal. The significance of the intimate personal relationship between physician and patient cannot be too strongly emphasized, for in an extraordinarily large number of cases both diagnosis and treatment are directly dependent on it, and the failure of the young physician to establish this relationship accounts for much of his ineffectiveness in the care of patients.

INSTRUCTION IN TREATMENT OF DISEASE

Hospitals, like other institutions founded with the highest human ideals, are apt to deteriorate into debasing machines, and even the physician who has the patient's welfare most at heart finds that pressure of

* One of a series of talks before the students of the Harvard Medical School on "The Care of the Patient."

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

> “the secret of the care of the patient is in caring for the patient”
>
> — Francis W. Peabody, 1927

UNIVERSITÄTSmedizin. MAINZ
I. Medizinische Klinik und Poliklinik
Schwerpunkt Nephrologie
Leitung: Prof. Dr. med. Julia Weinmann-Menke

Changes in the landscape of contrast nephropathy

PD Dr. med. Daniel Kraus
Attending physician, Division of Nephrology
Ist Department of Medicine
University Medical Center, Mainz, Germany