

1/ Hey #NephSky! 🙌

We're back with a fresh #Skytorial

We spend half our lives worrying about how bad creatinine is.. then keep using it anyway.

So what if we could measure GFR at the bedside - no serial blood samples? Let's talk transdermal GFR (tGFR).

@ISNkidneycare



2/ Our #Xtorial is by Akshaya J @DrAkshayaJ, adult nephrologist from @CMCNephrology - No COI

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3/

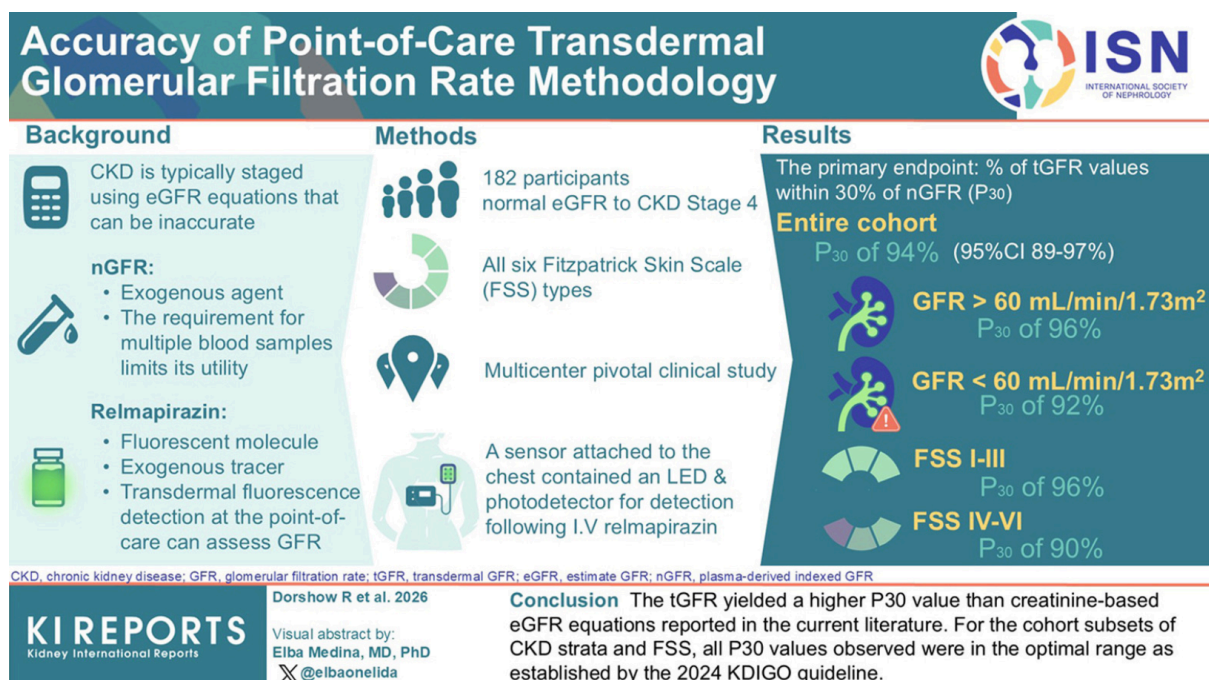
If a reliable, bedside mGFR (no blood sampling) is available, how would you use it?

- A) Replace eGFR in most patients
- B) Use in selected high-risk cases only
- C) Nice idea, but impractical
- D) Not convinced it adds value

4/ In a field built on inference and probability, can a transdermal signal truly bring us closer to a patient's real GFR than the biochemical surrogates we've trusted for decades?

Dorshow et al. Accuracy of Point-of-Care Transdermal GFR Methodology

[https://www.kireports.org/article/S2468-0249\(26\)00028-8/fulltext](https://www.kireports.org/article/S2468-0249(26)00028-8/fulltext)



by @elbaonelida

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Quick reset on GFR measurement.

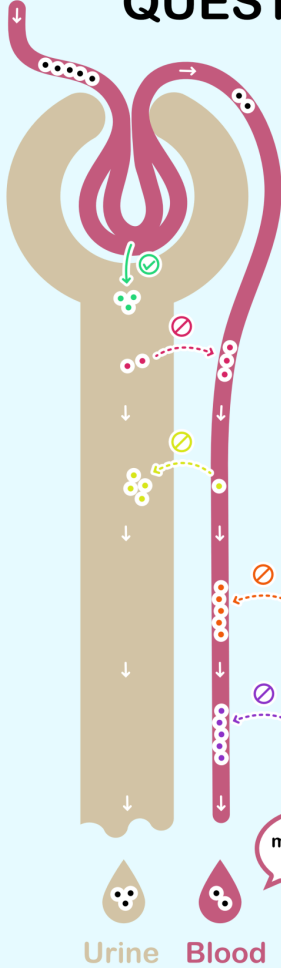
What we want : True filtration (exogenous marker clearance)

What we use: Creatinine / cystatin C equations

Convenient? Yes.

Accurate for an individual patient? Not really.

ESTIMATED GLOMERULAR FILTRATION RATE: QUEST FOR A PERFECT BIOMARKER



	CREATININE The Classic	CYSTATIN C New Kid on the Block
FREELY FILTERED	✓	✓
NOT REABSORBED	✓	✓
NOT SECRETED	✗ <i>A bit secreted, which is affected by early CKD and by certain drugs*</i>	✓
NOT HIGHLY AFFECTED BY MUSCLE MASS	✗ <i>Skewed by very high or low muscle mass*</i>	✓
NOT HIGHLY AFFECTED BY NON-KIDNEY DISEASES	✓	✗ <i>Levels may rise due to conditions unrelated to GFR*</i>

**Secretions can be enhanced in early CKD or blocked by drugs including TMP-SMX, pip-tazo, and salicylates*

**HIGH muscle mass → HIGH levels → UNDER-estimate GFR*
LOW muscle mass → LOW levels → OVER-estimate GFR


**Conditions include diabetes, corticosteroid use, and inflammation*

Urine Blood

measure me!


CREATED BY ARIELLA COLER-REILLY
@ARIELLA STUDIES
FOR THE CORE IM PODCAST

CORE IM



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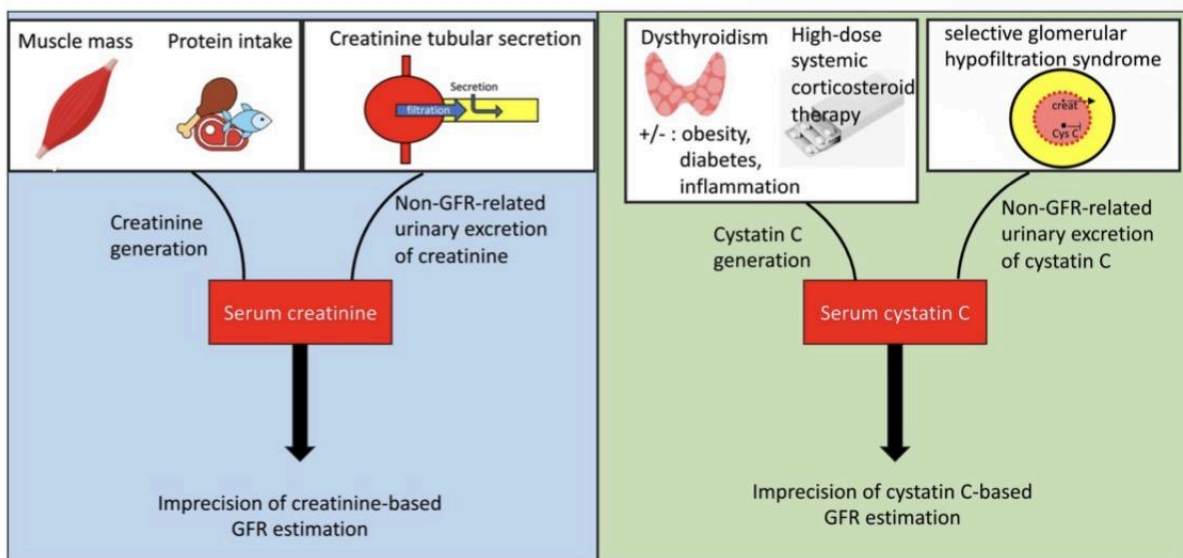
Why eGFR struggles:

Creatinine is messy: Depends on muscle mass, Tubular secretion  at low GFR & affected by diet, illness




Cystatin C helps... but then inflammation, obesity, steroids creep in.

So we're estimating a moving target.

#MedTwitter #nephtwitter



7/

Measured GFR (iohexol, iothalamate etc.) is the gold standard. But it requires:  multiple samples,  lab processing  time.

So we default back to creatinine... even when decisions really need precision.

#NephTwitter

Measured GFR

- Clearance **measured** with plasma or urinary methods record renal clearance of endogenous or exogenous substances
- Ideal substance: freely filtered at the glomeruli, neither secreted reabsorbed by the renal tubules
- Renal clearance of **inulin** is the gold standard in children and adults
- Inulin is not protein bound, freely filtered by the glomerulus and not secreted, metabolized, or reabsorbed by the renal tubules
- However need for continuous infusion, multiple blood and urine samples makes it difficult, time consuming
- Alternatives exogenous markers: ^{51}Cr EDTA, $^{99\text{m}}\text{Tc}$ -DTPA radioisotopes, iohexol
- **In children owing to expense, time, requirement for multiple blood samples mGFR only reserved for situations where accuracy essential**

8/

This is a multicenter trial looking at a point-of-care system using a fluorescent tracer (Relmapirazin) detected through the skin. No iohexol curves. No 15 samples. Just... a sensor on the chest.

Naturally, skepticism peeks out.

How does tGFR work?

https://www.accessdata.fda.gov/cdrh_docs/pdf23/P230019C.pdf

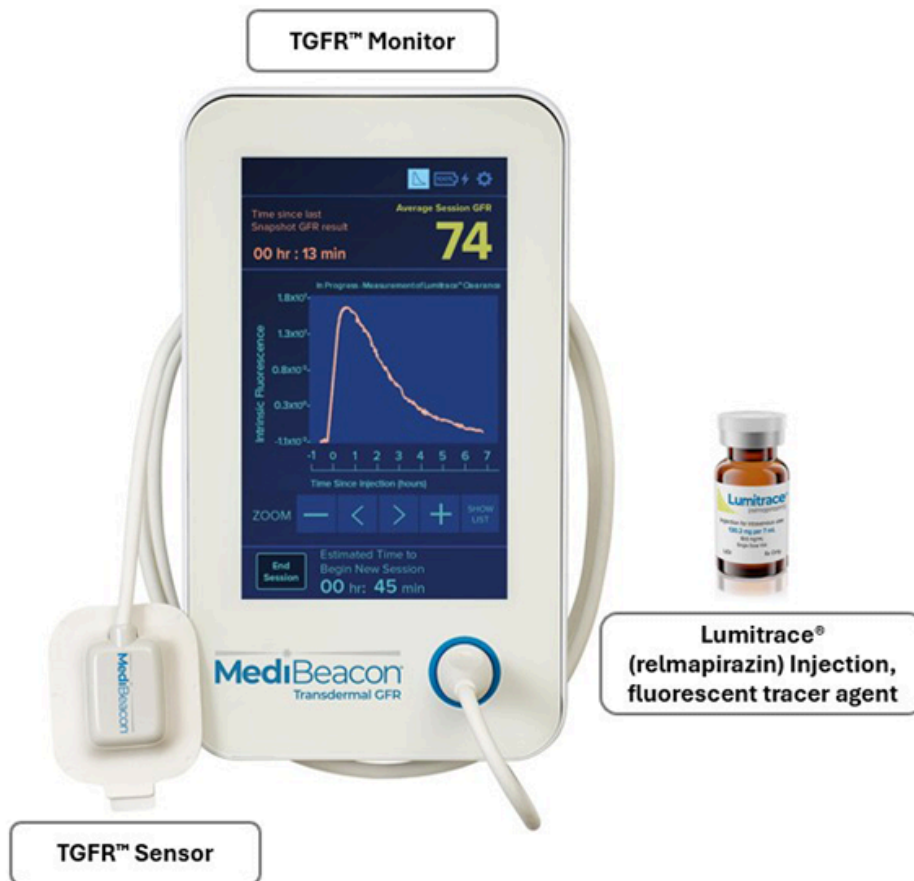
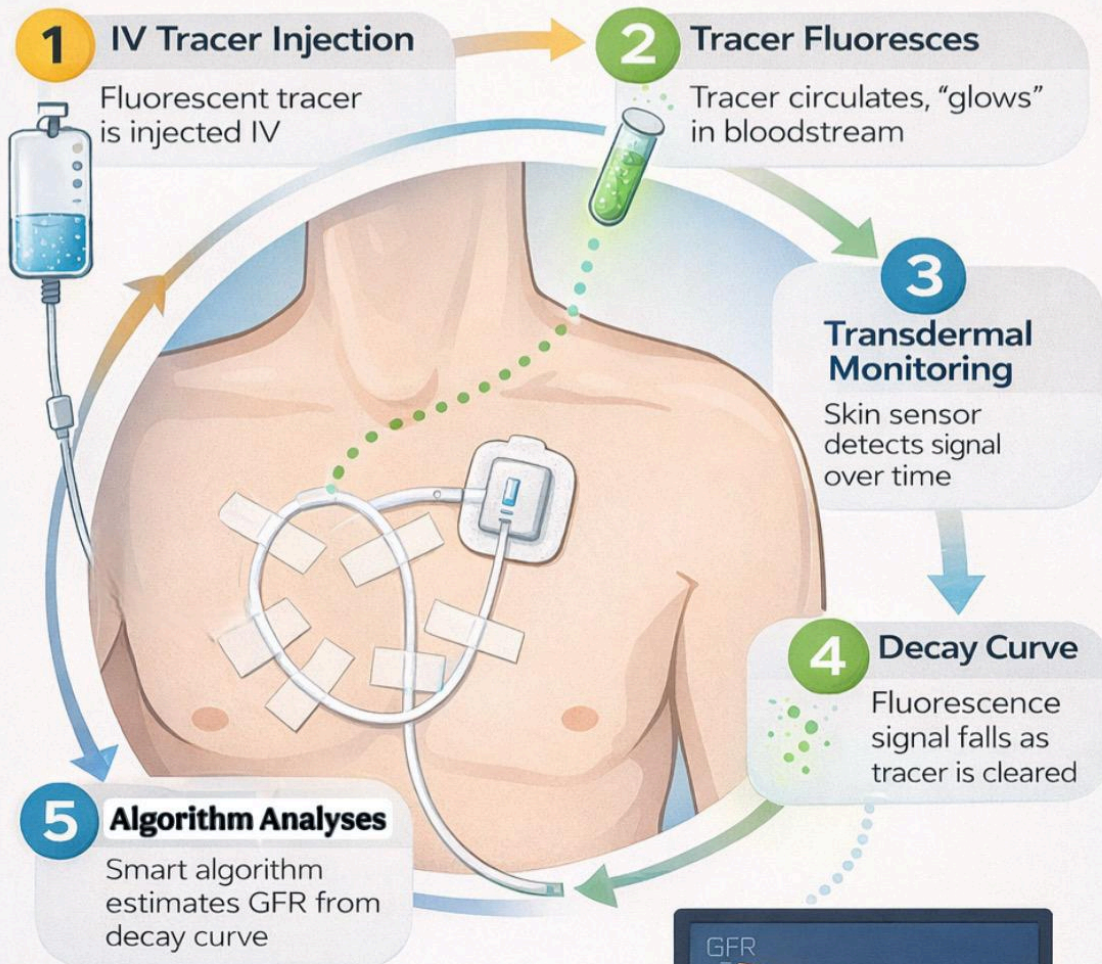


Figure 1. The transdermal glomerular filtration rate detection system. The 3 subsystems include the following: (i) the fluorescent tracer agent Lumitrace, (ii) the module containing the light source and photo detector, and (iii) and a display monitor that digitizes the acquired data and contains the algorithms to convert the output to glomerular filtration rate.

Transdermal GFR (tGFR)

Estimates **glomerular filtration rate** by tracking an IV tracer transdermally.



Key Points:


- Noninvasive, continuous, real-time GFR measurement
- Avoids confounders of **creatinine** or **cystatin C**
- *Needle to place IV drip only



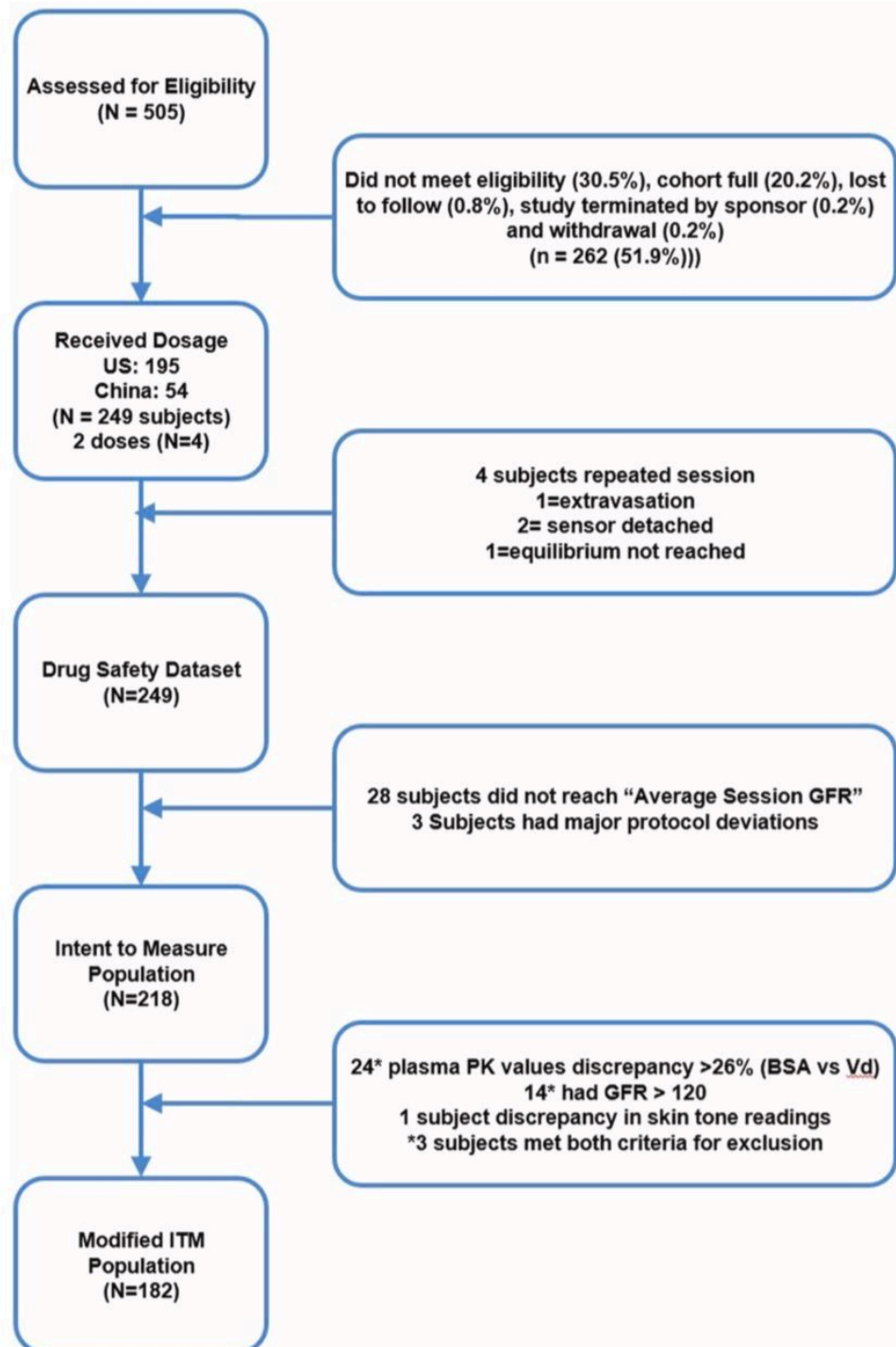
Transdermal Fluorescence Sensor

Adheres to shaved & cleaned skin |

* Needle to place IV drip only

9/  Study basics:

- Prospective, multicenter (US + China)
- n = 182
- GFR range: normal → CKD stage 4 (Stratified into eGFR > 70, and <15-60)
- Compared tGFR vs plasma-measured GFR (nGFR)
- **Primary endpoint: P30 accuracy** ⇒ % of tGFR values within 30% of the nGFR



Study Eligibility Criteria	
Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Age \geq 18 years 	<ul style="list-style-type: none"> • Pregnancy or planning pregnancy
<ul style="list-style-type: none"> • Able to provide informed consent directly 	<ul style="list-style-type: none"> • Positive COVID-19 test
<ul style="list-style-type: none"> • Able to comply with study protocol requirements and restrictions 	<ul style="list-style-type: none"> • Use of nonsteroidal anti-inflammatory drugs within 3 days prior to dosing
<ul style="list-style-type: none"> • Adequate venous access for blood sampling (plasma nGFR determination) 	<ul style="list-style-type: none"> • Significant scarring, tattoos, or altered pigmentation over sternum or sensor placement sites

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 Results:

Mean age 53y, diverse race, BMI ~29, and wide eGFR range.

P30 (% of tGFR values within 30% of the nGFR)

= 94% (CI ~89–97%)

Seems impressive. For context, most creatinine-based eGFR equations sit around ~80%.

Table 1. Aggregate demographics of the 182 study participants

Demographic characteristic	All	Stratum 1	Stratum 2
Mean age (yrs)	53 ± 15	48 ± 15	61 ± 14
Female, <i>n</i> (%)	70 (39)	37 (53)	33 (47)
Race, <i>n</i> (%)			
American Indian	1 (1)	1 (100)	0 (0)
Asian	54 (30)	29 (54)	25 (46)
Black	48 (26)	22 (46)	26 (54)
White	79 (43)	38 (48)	41 (52)
eGFR (ml/min per 1.73 m ²), <i>n</i> (%)			
> 90	60 (33)		
60–89	54 (30)		
45–59	35 (19)		
30–44	20 (11)		
< 30	13 (7)		
Mean BMI (kg/m ²)	29 ± 6	29 ± 5	29 ± 6
FSS, <i>n</i> (%)			
Type I	38 (21)	14 (37)	24 (63)
Type II	38 (21)	20 (53)	18 (47)
Type III	43 (24)	26 (60)	17 (40)
Type IV	26 (14)	16 (62)	10 (38)
Type V	18 (10)	06 (33)	12 (67)
Type VI	18 (10)	09 (50)	09 (50)

BMI, body mass index, eGFR, estimated glomerular filtration rate; FSS, Fitzpatrick Skin Scale.

Where applicable in the table, errors are +/- SD.

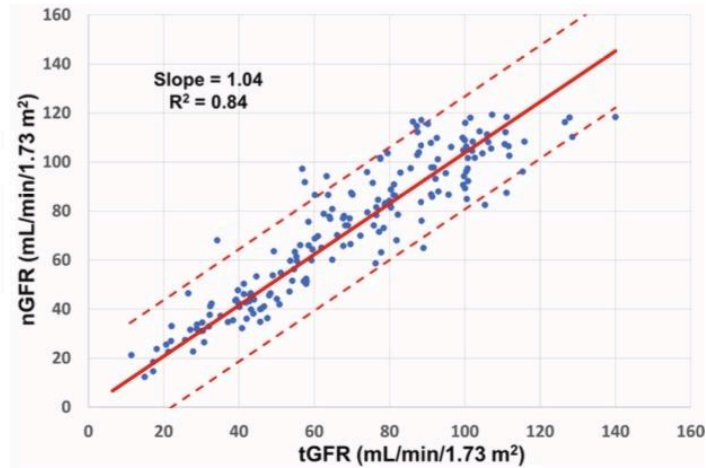


Figure 3. The nGFR versus tGFR for the 182 participants in the study. The linear regression (red) line has a slope of 1.04, with 95% confidence interval of 1.01 to 1.06, and $r^2 = 0.84$. The dashed lines are the 95% lower and upper confidence interval bounds around the data. nGFR, indexed plasma glomerular filtration rate; tGFR, transdermal glomerular filtration rate.

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Classified based on eGFR:

- GFR >60 → P30 ~96%
- GFR <60 → P30 ~92%

So performance holds even in CKD.

That's usually where Creatinine eGFR starts getting shaky.

Safety appears reassuring with no adverse effects

Table 3. Primary end point evaluation by CKD stratum

Attributes	Stratum 1	Stratum 2	Total
Number of subjects	90	92	182
P ₃₀ point estimate (%)	95.6	92.4	94.0
P ₃₀ lower 95% confidence bound (%)	89.0	84.9	89.4
P ₃₀ upper 95% confidence bound (%)	98.8	96.9	96.9

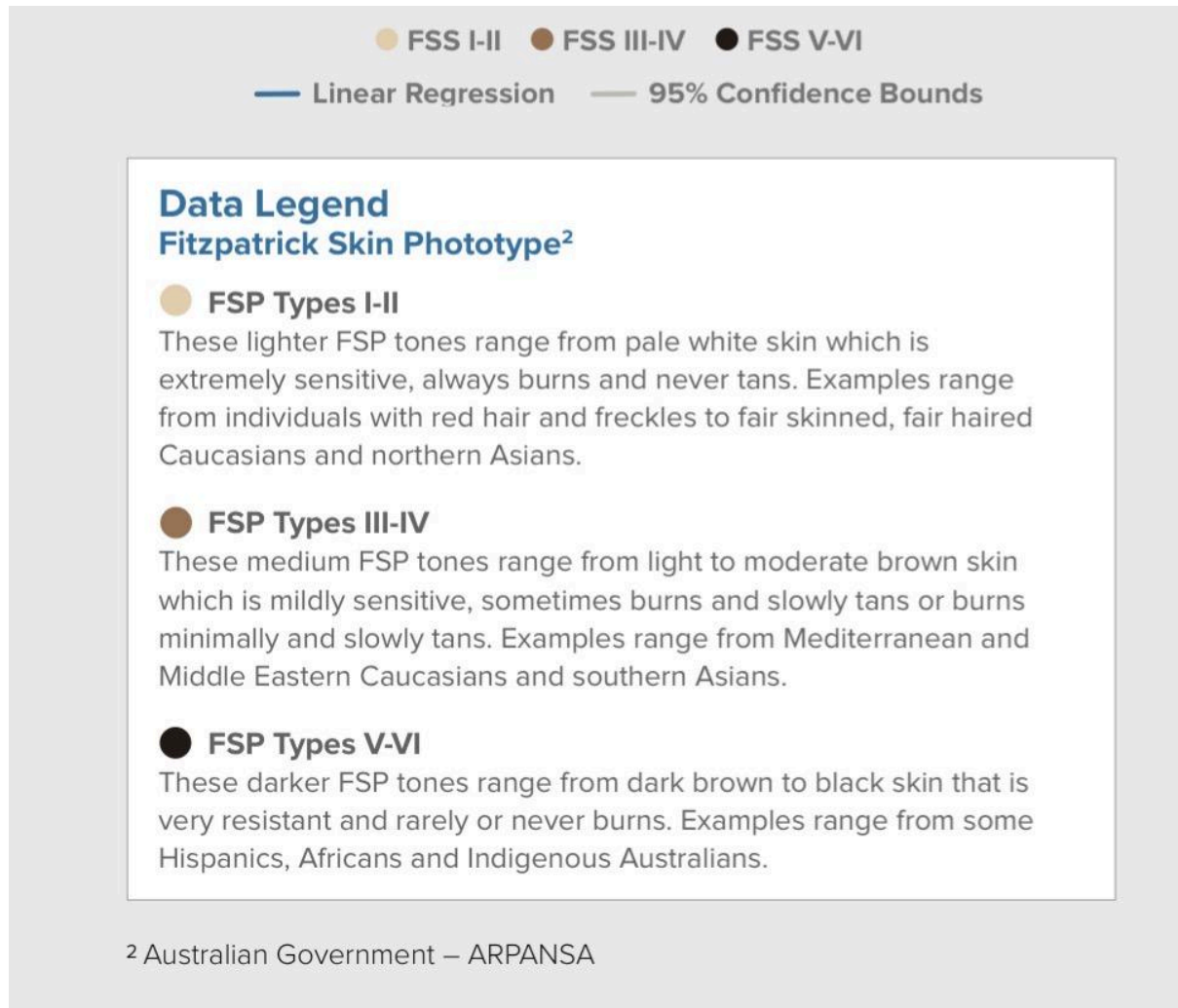
CKD, chronic kidney disease; P₃₀, percentage of transdermal glomerular filtration rate values within 30% of indexed plasma glomerular filtration rate.

12/

Now, the part I was most curious about:

Skin tone. 🧑🏻🧑🏼🧑🏽🧑🏾

Because anything transdermal → red flag 🚩 for bias.



13/

They actually took up patients from all skin tones:

All Fitzpatrick skin types (I–VI).

Result?

👉 No association between skin color and accuracy. That's a significant point.

The signal was also fairly stable across sex, and BMI.

Table 4. Primary end point evaluation by FSS

Attributes	Type I-III	Type IV-VI	Total
Number of subjects	120	62	182
P ₃₀ point estimate (%)	95.8	90.3	94.0
P ₃₀ lower 95% confidence bound (%)	90.5	80.1	89.4
P ₃₀ upper 95% confidence bound (%)	98.6	96.4	96.9

FSS, Fitzpatrick Skin Scale; P₃₀, percentage of transdermal glomerular filtration rate values within 30% of indexed plasma glomerular filtration rate.

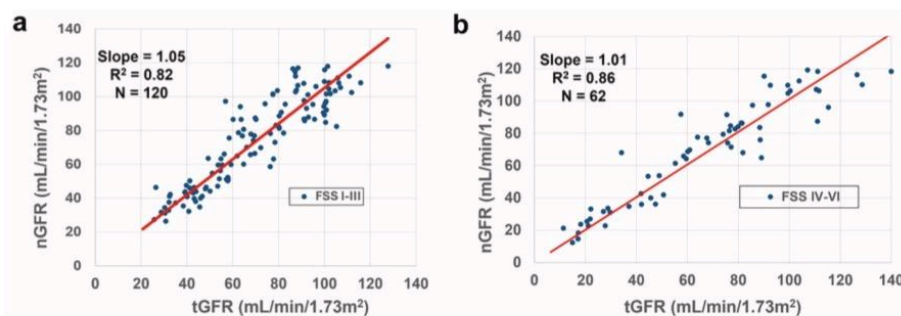


Figure 5. Subgroup FSS analysis. The nGFR versus tGFR for (a) FSS types I to III grouping and (b) FSS types IV to VI grouping. The red line is the linear regression with slope and *r-squared* values on graph (P₃₀ subgroup analyses in Tables 3 and 4). FSS, Fitzpatrick Skin Scale; nGFR, indexed plasma glomerular filtration rate; P₃₀, percentage of tGFR values within 30% of nGFR; tGFR, transdermal glomerular filtration rate.

Table 6. P₃₀ for individual FSS types

FSS	P ₃₀ n/N (%)
Type I	37/38 (97.4)
Type II	37/39 (94.9)
Type III	41/43 (95.3)
Type IV	23/26 (88.5)
Type V	18/18 (100.0)
Type VI	15/18 (83.3)
Overall	171/182 (94.0)

FSS, Fitzpatrick Skin Scale; P₃₀, percentage of transdermal glomerular filtration rate values within 30% of indexed plasma glomerular filtration rate.

P = 0.12 and 0.14 for the 2-sided Cochran-Armitage trend test asymptotic and exact tests, respectively.

Table 2. nGFR versus tGFR slope for subgroups of the study population with comparison to the “all participants” slope of 1.04 with 95% CI of 1.01–1.06

Demographic category	Sub group	nGFR vs. tGFR slope (unitless)	Lower 95% confidence bound	Upper 95% confidence bound	R ²	% relative to “all participants” value of 1.04	Sample size	RMSE (ml/min per 1.73 m ²)	Bias (tGFR – nGFR) (ml/min per 1.73 m ²)
All participants		1.04	1.01	1.06	0.84	-	182	11.6	-3.6
FSS (Type)	I–III	1.05	1.02	1.08	0.82	1	120	11.4	-4.3
	IV–VI	1.01	0.97	1.05	0.86	-3	62	11.8s	-2.4
Biological sex	Female	1.02	0.98	1.05	0.84	-2	70	10.7	-2.2
	Male	1.05	1.02	1.08	0.83	1	112	12.1	-4.5
BMI (kg/m ²)	< 30	1.02	1.00	1.05	0.85	-2	114	11.2	-2.4
	> 30	1.06	1.02	1.11	0.82	2	68	12.1	-5.7

BMI, body mass index; FSS, Fitzpatrick Skin Scale; nGFR, indexed plasma glomerular filtration rate; tGFR, transdermal glomerular filtration rate; RMSE, root mean square error.

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Why does it matter ?

eGFR errors aren’t just academic, they lead to:

- Drug dosing errors
- CKD misclassification
- Transplant timing delays

We know this already... we just tolerate it.

This System has a Sensor on chest, Single IV tracer dose, Real-time signal → GFR. Quite practical “bedside GFR”

15/ ⚠ Limitations:

1) tGFR was compared to eGFR, not gold-standard measured GFR (iohexol/iothalamate), so it’s essentially one surrogate vs another.

2) ~40% of patients were excluded due to technical issues (sensor detachment, acquisition/analysis errors) - a major concern in real practice

16/ Is a 30% margin (P30) acceptable when we’re dosing chemo or nephrotoxins?

!?! How would this perform in real patients - AKI, ICU, Edema, paedts?

!?! Are we ready to move from a \$10 creatinine test → device + tracer-based system?

Accuracy is one thing. Adoption is a different battle.

Transdermal GFR Cost

Right now, transdermal GFR (tGFR) isn't something you'll find priced like a routine lab test yet—it's still early in clinical rollout.



\$ Current cost: real-world estimate

Device-based test:

₹16,000–40,000
per test (\$200–500)

- The fluorescent tracer (e.g, relmapirazin / Lumitrac)
- Use of the monitoring device
- Clinical setup



Why it's expensive (for now)

- Proprietary tracer + device combo
- Limited availability (mostly research / early adoption centers)
- Not yet scaled like creatinine testing

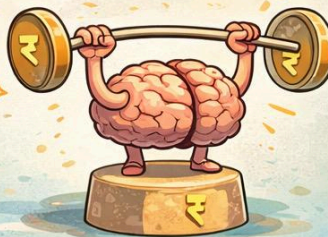


The bigger picture

- If this scales:
 - Cost could drop significantly
 - Could move from “research tool” → “clinic-friendly measurement”
 - That's where the real disruption lies

How it compares

- **Creatinine eGFR:**
₹100–300 → cheap, indirect, everywhere
- **₹5,000–15,000** — accurate but cumbersome



17/

tGFR still needs:

- IV access
- A device
- Time for signal acquisition - it's not replacing creatinine in your OPD tomorrow.

Can be trialed in: Oncology dosing, ICU / dynamic kidney function, Transplant evaluation, low muscle mass.

Basically where eGFR is most unreliable.



18/

🧠 Take-home:

tGFR is a promising step toward making measured GFR clinically usable.

But it may not be ready for routine use yet, given the lack of validation against gold-standard mGFR and technical issues that could affect real-world reliability.

Rx only



19/

🗨️ Curious what you think:

Would you actually use a bedside GFR device

if it was available in your unit?

Or are we too comfortable with creatinine chaos?

