Medical School Environments and Physician Treatment Styles

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November 6, 2026

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...to what extent are physician beliefs about what constitutes clinically appropriate care primarily forged during training and to what extent are they potentially malleable to subsequent information...?

– Finkelstein and Skinner, "Regional Variations and Productivity Puzzles in Health Care"

This paper

We ask whether training environment has a lasting impact on later-career treatment decisions.

- **Training environment:** Medical school HRR cath lab exposure
- **Treatment decision:** Invasive treatment in partial blockage heart attacks
- **Methodology:** Mover design

Literature review

Well-documented differences in physician practice style and health care utilization

- Evidenced by geographic variation in health care utilization Finkelstein et al. (2016), Cutler et al. (2019). Badinski et al. (2023)
- Practice style evolution caused by peer effects Molitor (2018), financial incentives Clemens et al. (2024), and new research DeCicca et al. (2024)

Limited evidence on the role of training in forming practice style

- Variation not explained by residency program Epstein and Nicholson (2009)
- Relies on rank as a proxy for quality Doyle Jr et al. (2010), Schnell and Currie (2018)

Contribution

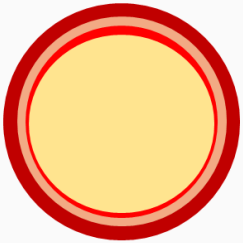
Identify a specific channel through which medical school impacts practice

- Quantify medical school environment using exposure to procedural technology
- Show that the training effect from that exposure lasts when controlling for rank

Human capital formation: Initial training vs. accrued experience

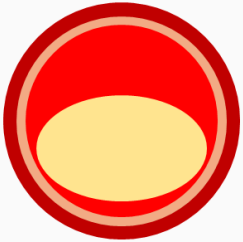
- Isolate training effect from current market effects

Treatment setting



STEMI

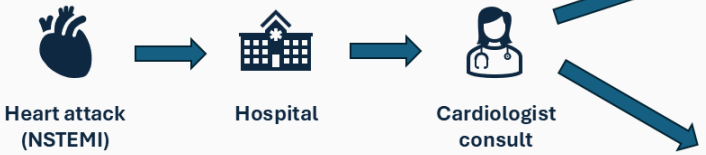
- Complete artery blockage
- Clear medical guidelines



NSTEMI

- Partial artery blockage
- More physician discretion

Treatment setting



Invasive treatment

- Coronary artery bypass surgery (CABG)
- Percutaneous coronary intervention (PCI)

Non-invasive treatment

- Medical management, including beta blockers or other drug therapy

Data: Treatment style

100% FFS Medicare claims (2008-2018)

- Treatment style is a risk-adjusted propensity to recommend a cardiac cath
- Treatment decision: Cardiac cath within two days of admission
- Patient population: First-time NSTEMI patients

Data: Treatment style

Residualize for patient risk at the patient-level

$$\mathbb{1}\{\text{cardiac cath}\}_{jt} = \mathbf{X}_{jt}'\boldsymbol{\theta} + \gamma_t + \varepsilon_{jt}$$

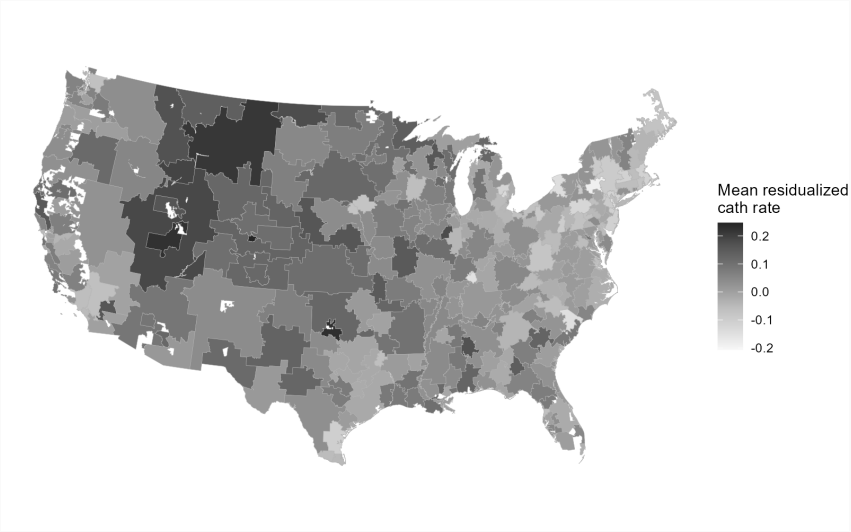
- $\mathbf{X}_{jt}$ includes patient age, sex, race, dual eligibility, Elixhauser comorbidities
- γ_t = year FE

Aggregate to the cardiologist-year level

Treatment style

y_{it} = mean residualized cath rate of cardiologist i in year t

Treatment styles across markets



Data: Training environment

CMS Physician Compare: Medical school and graduation year

American Hospital Association Annual Survey (1980-present): Cath lab availability

- Aggregate to the HRR-year level

Medical school environment

τ_i = share of hospitals with a cath lab in cardiologist i's medical school HRR in the year after their matriculation

Additional data sources

On cardiologists

- **Medicare Data on Provider Practice and Specialty**: Specialty, primary practice location
- **Doximity**: Residency and fellowship program, graduation year

On medical schools

- **NIH ExPORTER**: NIH funding by medical school and year

Summary statistics

	Mean	SD	Min	Max	N
Cardiologist-year level					
Residualized cath rate	0.028	0.160	-0.547	0.574	15,084
NSTEMI volume per year	16.3	6.2	11.0	148.0	15,084
Training-HRR cath lab share	0.309	0.168	0.000	0.833	15,084
Current-HRR peer cath rate (LOO)	0.018	0.078	-0.335	0.410	15,084
Hospital-based share of claims	0.544	0.218	0.041	1.000	15,084
Log TIN-level patient volume	7.235	0.522	4.043	9.166	15,084

Summary statistics

	Mean	SD	Min	Max	N
Cardiologist level (per NPI)					
Graduation year	1993.7	6.9	1983.0	2006.0	4,033
Years observed in panel	3.7	2.7	1.0	10.0	4,033
Female	0.099				4,033
General Cardiology	0.728				4,033
Interventional Cardiology	0.206				4,033
Electrophysiology	0.054				4,033
Advanced Heart Failure	0.011				4,033

Empirical strategy

Cross-sectional mover design

- Mover = different med school HRR and current practice HRR
- Control for both med school and current practice markets
- Control for current practice environment

Stayers: Med school and current practice markets are the same

Movers: Isolate the training effect

Empirical strategy

$$y_{it} = \beta_{\text{train}}\tau_i + \theta\bar{y}_{-i,t} + \rho_{m(i)} + \delta_{d(i,t)} + \gamma_t + \epsilon_{it}$$

- y_{it} = mean residualized cath rate of cardiologist i in year t
- τ_i = training-period cath lab availability in cardiologist i's medical school HRR
- $\bar{y}_{-i,t}$ = leave-one-out mean residualized cath rate of other cardiologists in cardiologist i's practice HRR in year t
- $\rho_{m(i)}$ = medical school HRR fixed effect
- $\delta_{d(i,t)}$ = current practice HRR fixed effect
- γ_t = year fixed effect

Empirical strategy

Identifying variation: Different cath lab exposure among cardiologists who attended medical school in the same HRR but graduated in different years

Identifying assumption: Within-HRR cath lab adoption is uncorrelated with changes in other cohort-level determinants of practice intensity

Movers vs stayers

	Movers	Stayers	Diff.	p-value
Graduation year	1993.7	1993.7	-0.0	0.895
Female (%)	9.6	11.5	-1.9	0.170
General Cardiology (%)	72.7	73.8	-1.2	0.553
Interventional Cardiology (%)	20.8	19.5	1.3	0.451
Electrophysiology (%)	5.4	5.5	-0.1	0.912
Adv. Heart Failure (%)	1.1	1.2	-0.1	0.900
Training-HRR cath lab share	0.329	0.280	0.049	0.000
Years in panel	3.8	3.5	0.3	0.026
Mean NSTEMI volume per year	14.7	14.5	0.2	0.177
First observation year	2011.1	2011.2	-0.1	0.249
Cardiologists	3,433	600		

Training environment impacts later treatment decisions

	Baseline	Physician char.	Physician and practice char.
Training-HRR cath lab share	0.058***	0.069**	0.080**
	(0.021)	(0.032)	(0.031)
Current-HRR cath culture (LOO)	0.083***	0.083***	0.086***
	(0.028)	(0.027)	(0.027)
Observations	15,083	15,083	15,083

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

A 10pp higher cath lab share during training raises a cardiologist's cath rate by 0.58pp.

No med school HRR FE

Robustness

	Baseline	IPW	Linear cohort trend
Training-HRR cath lab share	0.058***	0.058***	0.065**
	(0.021)	(0.020)	(0.031)
Observations	15,083	15,083	15,083

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

1. Selection into being a mover
   - Reweigh using IPW so that movers and stayers look alike on observables

   → Training coefficient stays the same

Robustness

	Baseline	IPW	Linear cohort trend
Training-HRR cath lab share	0.058***	0.058***	0.065**
	(0.021)	(0.020)	(0.031)
Observations	15,083	15,083	15,083

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

2. Estimate reflects national trends in cath availability, not local changes
   - Add a linear graduation year trend

   → Training coefficient stays stable

Training effect is concentrated among interventional cardiologists

	General Cards	Interventional
Panel A. Baseline		
Cath lab share, training HRR	0.012	0.059***
	(0.018)	(0.020)
Observations	10,801	3,585
Panel B. + Physician characteristics		
Cath lab share, training HRR	-0.001	0.055**
	(0.018)	(0.021)
Observations	10,801	3,585
Panel C. + Practice characteristics		
Cath lab share, training HRR	0.001	0.048**
	(0.019)	(0.022)
Observations	10,801	3,585

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Is the training effect concentrated in riskier patients?

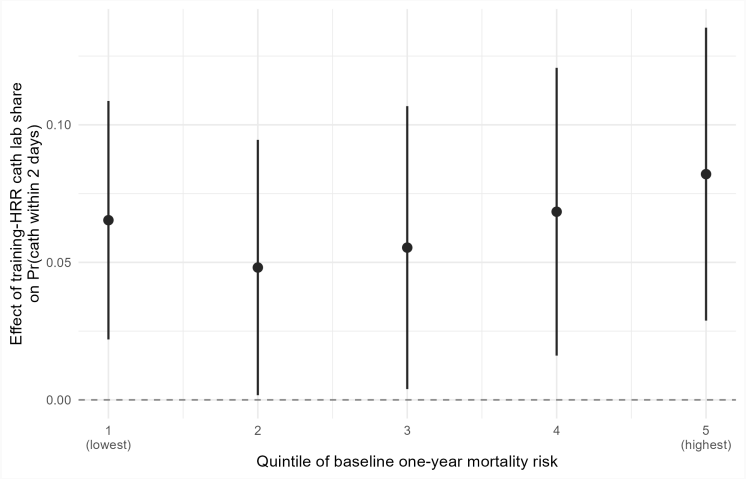
- Does training improve a cardiologist's ability to match procedure to patients?
- If yes, then training effect should be concentrated in higher risk patients

For cardiologist i and patient j,

$$\mathbb{1}\{\text{cath in two days}\}_j = \beta_{\text{train}}\tau_i \times \mathbb{1}\{\text{patient risk quintile}\}_j + \theta\bar{y}_{-i,t} + \rho_{m(i)} + \delta_{d(i,t)} + \gamma_t + \epsilon_{it}$$

where patient risk $=$ predicted one-year mortality

Training effect does not differ for riskier patients



Mortality by risk quintile

Training effect persists after controlling for medical school rank

	Med school rank only	With training environment	With physician and practice char.
$-\log$(NIH rank)	0.006**	0.005*	0.005*
	(0.003)	(0.003)	(0.003)
Training cath lab share		0.058***	0.075**
		(0.021)	(0.032)
Observations	14,879	14,879	14,879

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Using rank tier indicators | Top of rank distribution

What about residency?

Medical training has multiple stages, not just medical school

- Medical school → residency → fellowship

Control for exposure to cath labs during residency

1. Whether cardiologist's **own residency hospital** has a cath lab
2. **Share of hospitals** within same-HRR system that have a cath lab

Training effect persists after controlling for residency exposure

	Residency exposure variable	
	Own hospital	System share
Medical school cath share	0.100***	0.104***
	(0.030)	(0.031)
Residency exposure	0.015*	0.013
	(0.009)	(0.008)
Cardiologist-years	6,955	7,045
Cardiologists	1,838	1,864
Med-school HRR FE	Yes	Yes
Practice HRR FE	Yes	Yes
Year FE	Yes	Yes

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Using manual and exact name match

Long-run effect with peer spillovers

Practice styles evolve due to peer effects Molitor (2018)

↓

What is the impact of training when taking peer effects into account?

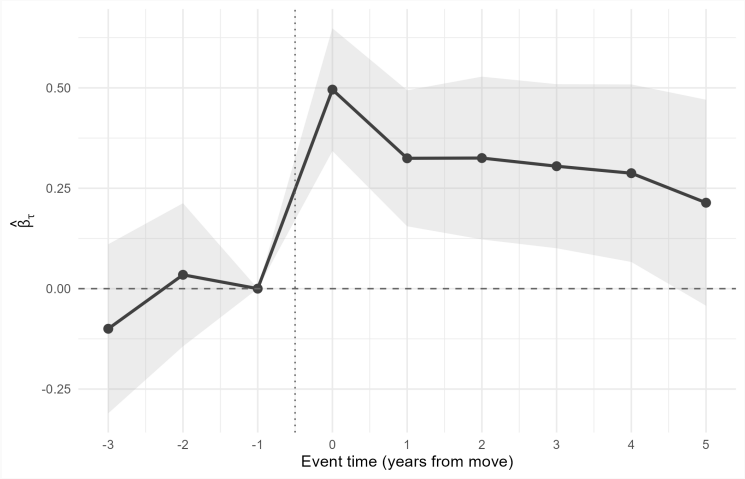
1. Estimate peer effect using cardiologists who move mid-career
2. Calculate the combined effect

Estimating the peer effect among mid-career movers

$$y_{it} = \alpha_i + \gamma_t + \sum_{\tau \neq -1} \beta_\tau \cdot \mathbb{1}[\tau_{it} = \tau] \cdot \Delta_i + \varepsilon_{it}$$

- y_{it} = mean residualized cath rate of cardiologist i in year t
- α_i = cardiologist fixed effect
- γ_t = year fixed effect
- Δ_i = LOO destination peer cath rate - LOO origin peer cath rate

Estimating the peer effect among mid-career movers



Outcome: Mean residualized cath rate

Pooled post-move coefficient $\beta_{dest} = 0.40$

By direction of move

Long-run effect with peer spillovers

$$\text{cath rate} = \beta_{train} \times (\text{training environment}) + \beta_{dest}(\text{peer's treatment styles}) + \text{error}$$

$$\text{Long run effect:} \quad \Delta\text{cath rate}^* = \frac{\beta_{train} \cdot \Delta\text{training environment}}{1 - \beta_{dest}}$$

- **Direct training effect:** $\beta_{train} = 0.058$
- **Peer effect:** $\beta_{dest} = 0.40$

Combining direct training effect and peer effect, a 10pp higher cath lab share during training raises a cardiologist's cath rate by 0.97pp.

Summary of results

Medical school has a lasting impact

- 10pp increase in cath lab availability during training increases later cath rates by 0.58pp
- Effect is concentrated among interventional cardiologists
- Does not go away after controlling for other aspects of training

Peer effects compound the impact

- If exposure rises for a whole peer group...
- 10pp increase in cath lab availability during training increases later cath rates by 0.97pp

Conclusion

Training effects persist throughout a physician's career, so later-career policies alone may not change practice patterns

- Training environment matters by about 1/3 as much as current practice environment
  Calculations
- Training effect is amplified by peer-to-peer learning

Policy implication

- Uniform technology access during training reduces practice style variation

Thank you!

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Training effect: No medical school HRR fixed effect

	Baseline	Physician char.	Physician and practice char.
Training-HRR cath lab share	0.032***	0.025*	0.025
	(0.011)	(0.014)	(0.015)
Current-HRR cath culture (LOO)	0.085***	0.085***	0.087***
	(0.028)	(0.028)	(0.027)
Observations	15,083	15,083	15,083

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

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Patient mortality by risk quintile

Risk quintile	Inpatient stays	Predicted one-year mortality	Cath within 2 days	Mortality	
				30-day	One-year
1	53,672	0.095	0.763	0.020	0.076
2	51,625	0.154	0.708	0.042	0.133
3	49,199	0.223	0.596	0.072	0.216
4	46,857	0.323	0.441	0.125	0.339
5	44,700	0.555	0.283	0.239	0.546

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Medical school rank: Rank tier indicators

Ref. = unranked	(1)	(2)	(3)
Top 51-100	0.007	0.009	0.006
	(0.011)	(0.011)	(0.011)
Top 26-50	0.003	0.004	0.002
	(0.013)	(0.013)	(0.013)
Top 11-25	0.016	0.018	0.016
	(0.012)	(0.012)	(0.012)
Top 10	0.022	0.023	0.019
	(0.015)	(0.015)	(0.015)
Training cath lab share		0.060***	0.076**
		(0.020)	(0.032)
Physician characteristics	No	No	Yes
Practice characteristics	No	No	Yes
Observations	14,879	14,879	14,879

back

Medical school rank: Top ranked schools

	(1)	(2)	(3)
Panel A. Top 25 schools			
Cath lab share, training HRR	0.014	-0.043	-0.042
	(0.034)	(0.036)	(0.033)
Observations	2,501	2,501	2,501
Panel B. Below Top 25 schools			
Cath lab share, training HRR	0.036***	0.032*	0.032*
	(0.014)	(0.017)	(0.018)
Observations	12,351	12,351	12,351
Physician characteristics	No	Yes	Yes
Practice characteristics	No	No	Yes
Practice HRR FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

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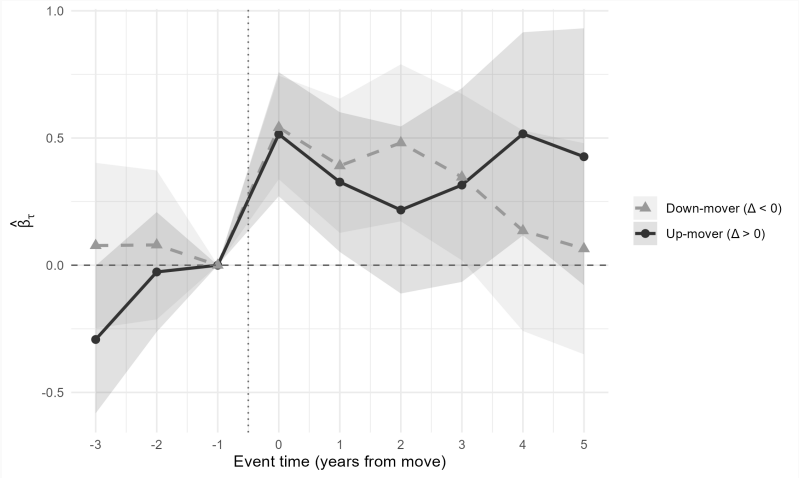
Residency: Exact name match

	Full sample		Manual+exact only	
	Own hospital	System share	Own hospital	System share
Medical school cath share	0.100***	0.104***	0.127***	0.135***
	(0.030)	(0.031)	(0.033)	(0.034)
Residency exposure	0.015*	0.013	0.021*	0.022**
	(0.009)	(0.008)	(0.012)	(0.010)
Cardiologist-years	6,955	7,045	5,595	5,681
Cardiologists	1,838	1,864	1,499	1,522
Med-school HRR FE	Yes	Yes	Yes	Yes
Practice HRR FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

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Peer effects: Mid-career movers by move direction



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Back-of-the-envelope: Comparing training and peer effects

Comparing a 1 SD change in training environment vs peer environment

	Coefficient	SD of variable	Effect of 1 SD change
Training exposure (τ_i)	0.058	0.168	$0.058 \times 0.168 = 0.0097$
Peer environment ($\bar{y}_{-i,t}$)	0.40	0.078	$0.40 \times 0.078 = 0.0312$

- **Direct training effect:** 0.97pp per SD, which is about 1/3 of the peer effect
- **Training with peers:** 1.62pp per SD, which is 1/2 of the peer effect

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