Work Flow Modeling in Primary Care Clinics

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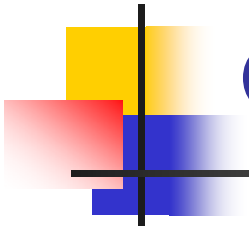


Outline

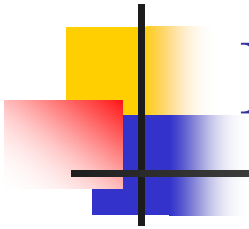
- Introduction
- Physician work flow model
- Joint visit model
- Team collaboration model
- Conclusions

Introduction

- As the backbone of nation's healthcare system, primary care is facing significant challenges.
- Physicians have become increasingly busy and over utilized to deal with overwhelming amounts of tasks, regulation pressures, and electronic health record (EHR) usages, which lead to growing burnout rates.
- Although substantial research has been devoted to analyzing physician workload, many of them are empirical or qualitative studies.
- Mathematical models can help evaluate physician workflow quantitatively and provide suggestions for improvement.

Introduction

- A general internist in a typical primary care clinic may spend his/her time in three major categories:
  - Time in exam room meeting with patients
  - Time in his/her office between patient visits
  - Time after hours catching up remaining work of the day.
- Thus, a physician is either having
  - face-to-face encounters with patients
  - interacting with other medical staff
  - working on their computers/tablets to document information related to patient visits, communicate with nurses, medical assistants or other staff electronically, carry out administrative work, and reply to in-basket electronic messages from patients, etc.

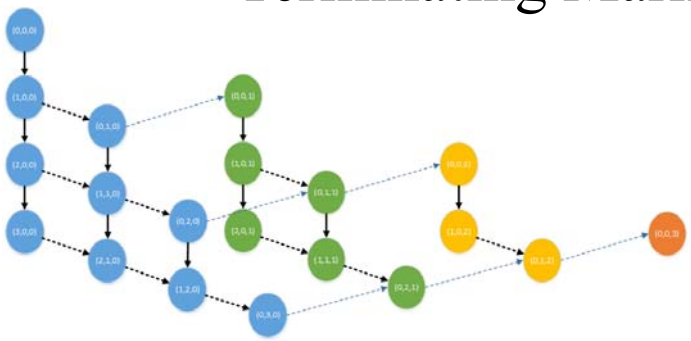


Introduction

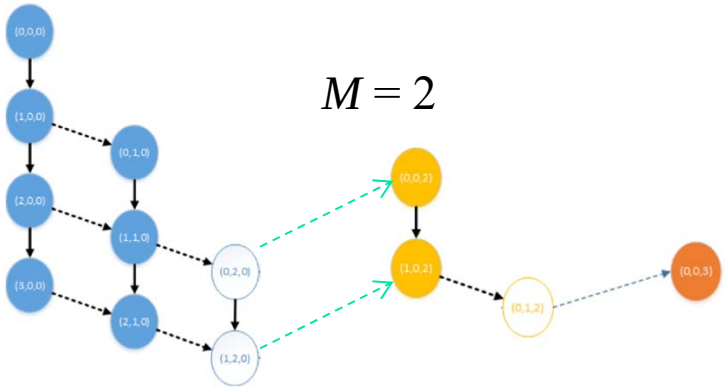
- In this talk, we will present recent studies related to work flow modeling in primary care clinics.
  - Physician work flow scheduling between face-to-face encounter and documentation work
  - Joint visits with both physician and medical assistant
  - Team collaboration between physician, nurse, and medical assistant
  - Case studies at Dean East Clinic of SSM Health

Physician Work Flow Model

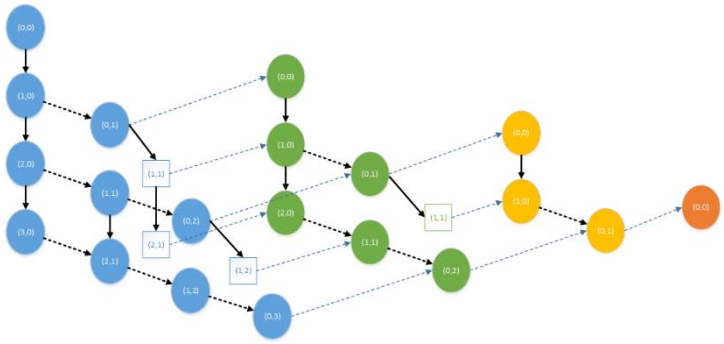
Terminating Markov Chain Models



Preemptive priority policy (PEP): see patients first



Batch documentation policy (BDC): starting documentation when achieving M



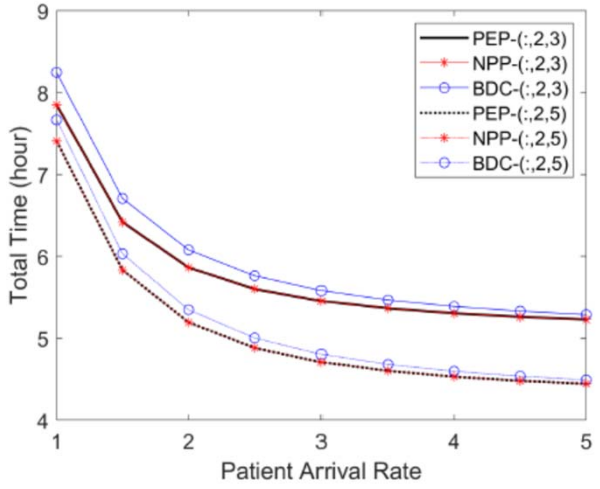
Non-Preemptive priority policy (NPP): finish ongoing documentation

- Daily work time: T
- Patient waiting time: W
- Documentation waiting time: Q

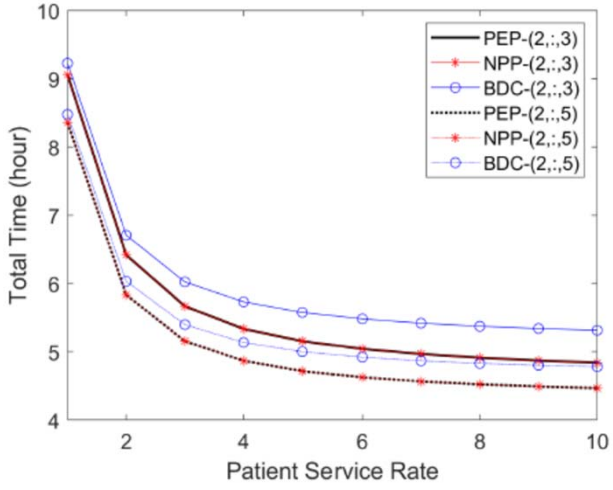
Result – Daily Work Time

- PEP and NPP models have the same daily work time, while BDC model has longer time.

$$T^{\mathrm{PEP}} = T^{\mathrm{NPP}} \leq T^{\mathrm{BDC}}$$



- Higher patient arrival rate, shorter daily work time
- Higher patient service rate, shorter daily work time

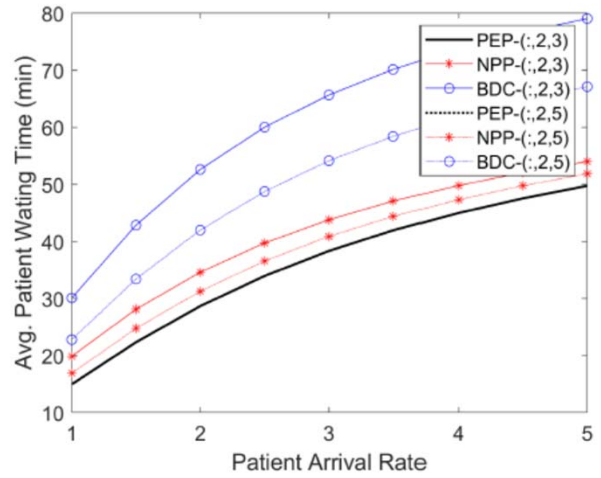


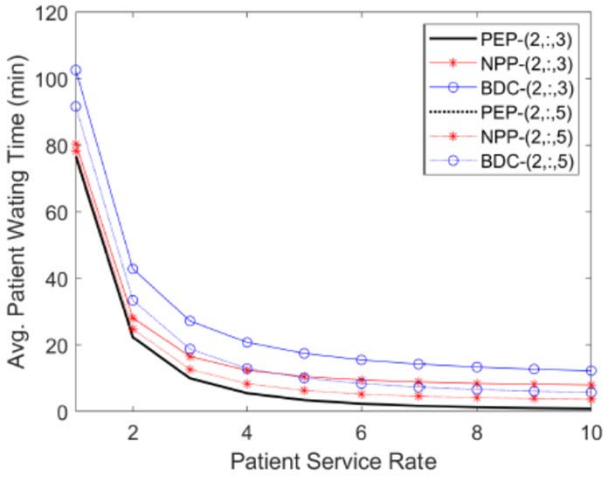
Result – Patient Waiting Time

- PEP model has the shortest patient waiting time, while BDC model has the longest time

$$W^{\mathrm{PEP}} < W^{\mathrm{NPP}} < W^{\mathrm{BDC}}$$

- Higher patient arrival rate, longer patient waiting time
- Higher patient service rate, shorter patient waiting time



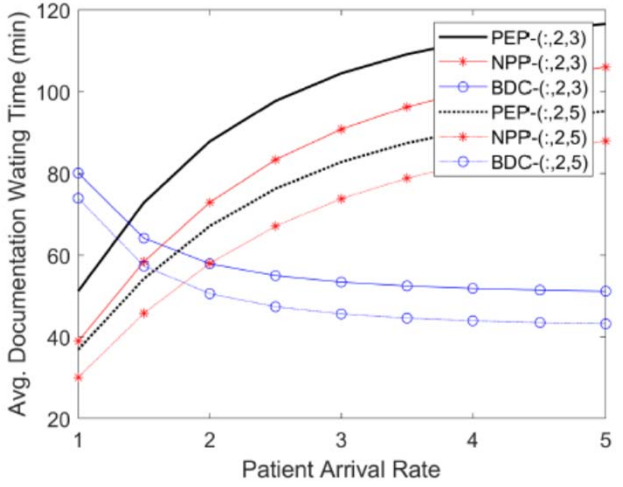


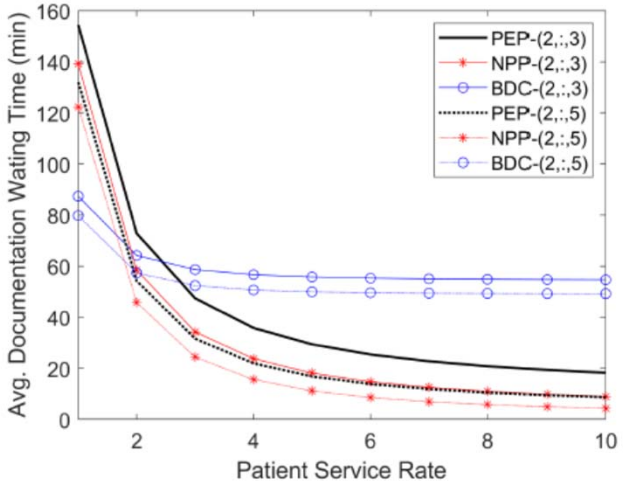
Result – Documentation Waiting Time

- BDC model shows different patterns from PEP and NPP models
- NPP model has shorter documentation waiting time than PEP model.

$$Q^{\mathrm{PEP}} > Q^{\mathrm{NPP}}$$

- Higher patient arrival rate, longer documentation waiting time in PEP and NPP models, but shorter in BDC model
- Higher patient service rate, shorter documentation waiting time, but not sensitive in BDC model





Discussion – Case Study

- Dean East Clinic, Madison, WI
  - 14 Patient visits are scheduled every 30 minutes
  - The physician works from 8 a.m. to 6:30. p.m., except 12:00~1:00, 4:00~6:30
  - The average face-to-face time that the physician spends with the patient is 14.6 minutes
  - The average time to work on a documentation task is 12.3 minutes
  - Total daily work time is over 11 hours after adding 3.5 hours

	PEP	NPP	BDC (M=3)	BDC (M=5)
Work time (hour)	7.95	7.95	8.14	8.38
Patient waiting time (min)	6.08	10.18	23.91	23.70
Documentation waiting time	36.86	28.20	33.56	68.58

- Either PEP or **NPP** policy is recommended.

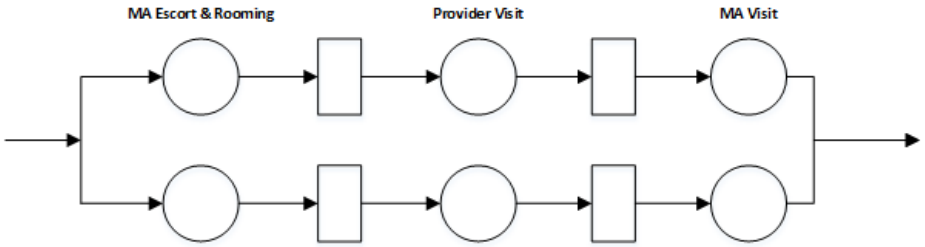
Joint Visit Model

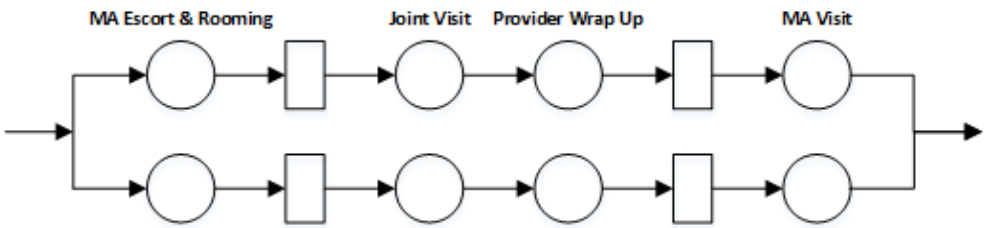
- As one of the efforts to redesign work flow, **joint visit** has been introduced to improve operation efficiency and reduce provider workload.
  - Medical assistant taking note during a physician's meeting with patient
- However, **no model is available yet** to quantify the joint visit's impact on patient flow and provider and staff utilizations.
- In addition, among different models of joint visits, adopting which one that leads to the highest efficiency is still unclear.

Joint Visit Model

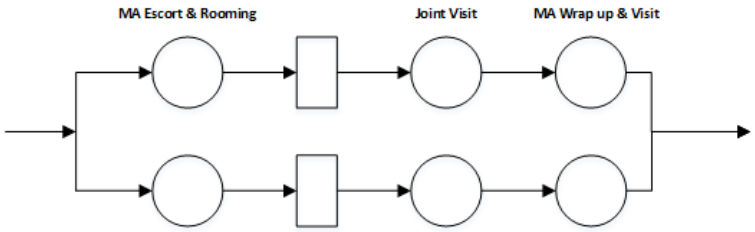
One provider, one MA, two exam rooms

Current model





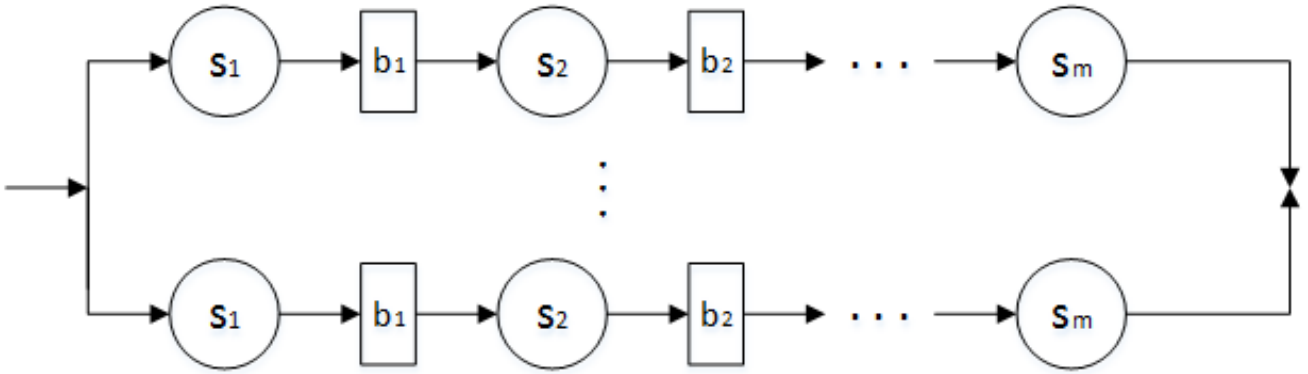
Joint visit with provider wrap-up



Joint visit with MA wrap-up

Joint Visit Model

Markov chain model



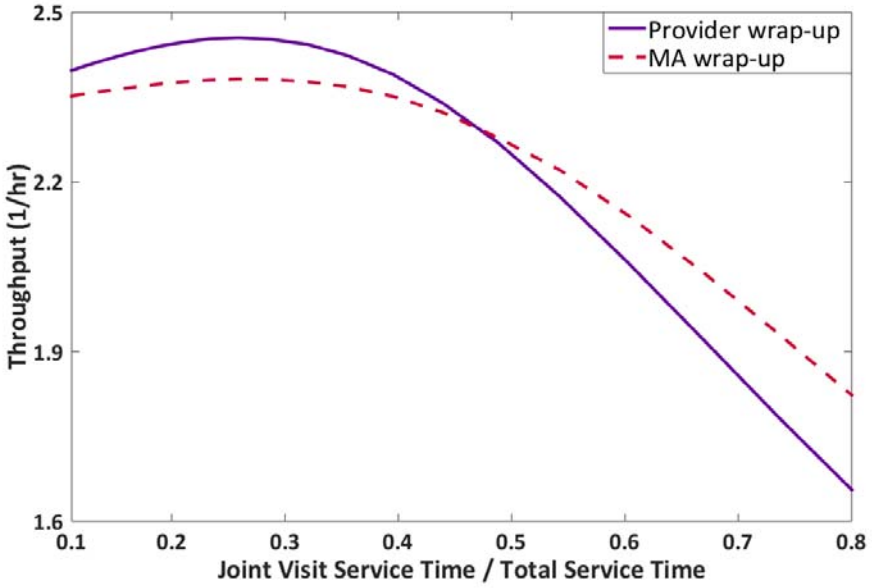
Define states as $S = (s_1, b_1, \ldots, s_{m-1}, b_{m-1}, s_m)$

s_i = number of patients receiving service by a resource (MA or provider)
b_j = number of patients who have finished service but are still waiting for the next stage.

Joint Visit Model

	Throughput	Length of visit	Provider utilization	MA utilization
Current	1.759	63.2	91.4%	34.2%
Joint/Provider wrap-up	1.920	60.83	96.8%	78.1%
Joint/MA wrap-up	2.034	54.28	90.7%	96.1%

Who should be responsible for wrap-up?



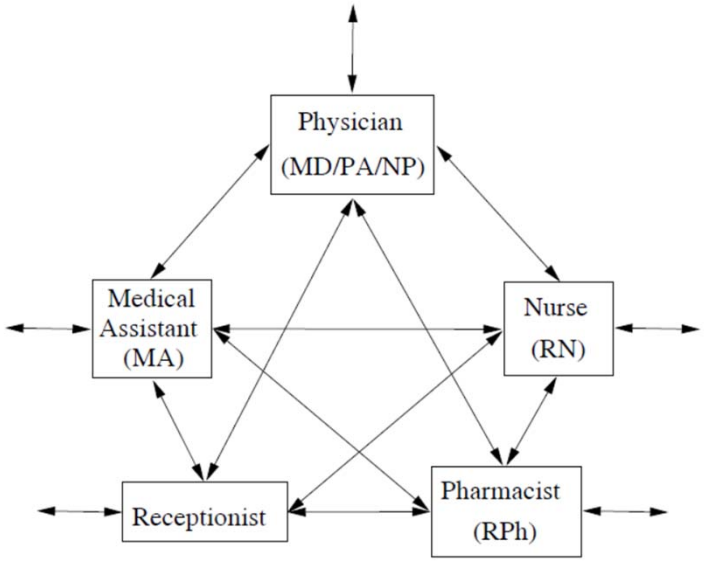
Overtime can be reduced substantially

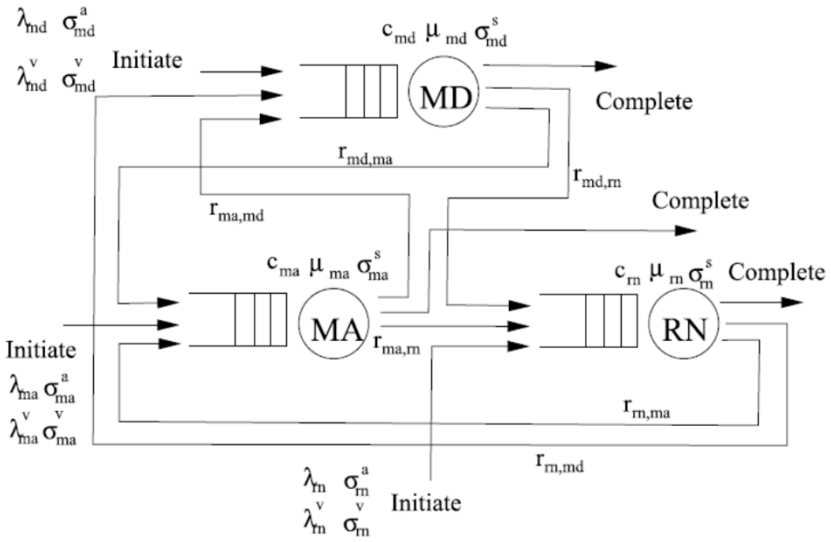
Team Collaboration Model

- In primary care clinics, a care service task typically requires joint team efforts among the care providers and support staff.
- Team communication and collaboration are critical to ensure high quality of care, thus have received a considerable amount of research attention.
- Most research is qualitative or based on empirical studies. An analytical framework of modeling, analysis, and improvement is needed.

Team Collaboration Model

- Queueing network model
  - Servers: physicians, nurses, and medical assistants
  - Customers: communication and collaboration tasks
  - Parameters: arrivals, services, routing probabilities
  - Outcomes: throughput, task completion time, the number of iterations to finish a task





Team Collaboration Model

Throughput

0.83 task/min
0.24 task/min finishing

Number of iterations

$$\eta_{\text{md}} = 3.42, \quad \eta_{\text{rn}} = 2.91, \quad \eta_{\text{ma}} = 3.88$$

Completion time

$\tau^{H,\text{gen}}$	$\tau^{L,\text{gen}}$	τ^{gen}
13.09	66.10	50.74

Bottleneck analysis

	$r_{\text{md,rn}}$	$r_{\text{md,ma}}$	$r_{\text{rn,md}}$	$r_{\text{rn,ma}}$	$r_{\text{ma,md}}$	$r_{\text{ma,rn}}$
$I_{\eta,r}$	0.94	1.26	1.15	1.30	0.60	0.51

Jobs routed to MAs?

Conclusions

- Work flow modeling can play a significant role to help improve care quality and balance physician workload
- Analytical models can provide quantitative analyses and what-if predictions
- More detailed, specified, and complex models and analyses are needed
- Integrating with clinical decision support is preferred

Thanks

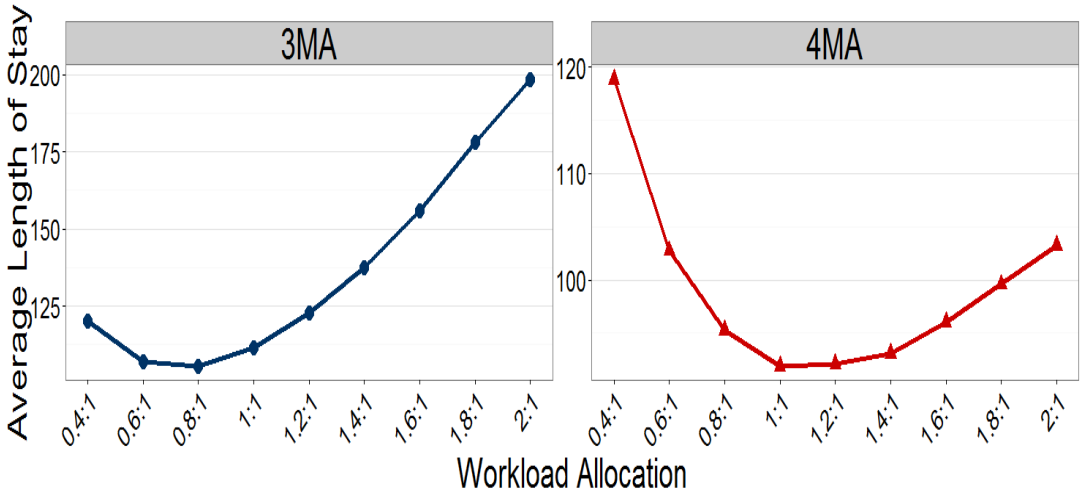
- SSM Health
- Dean Medical Group (Dean Health System)

Staffing Ratio Model

- **Staffing Model**
  - MA vs MD
  - 1:1, 2:1, 3:1?
  - Newton's Law?

$$\tau_1 + \tau_2 = \text{constant}.$$

$$\tau_1^* = \tau_2^*.$$



- Workload* balance law $\frac{W_{MD}}{N_{MD}} = \frac{W_{MA}}{N_{MA}}$ * direct contact

$$\frac{\text{Physician Workload}}{\text{Number of Physicians}} = \frac{\text{MA Workload}}{\text{Number of MAs}}$$