CENTER FOR
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Computer Simulation Modeling of a Competency Based Surgical Training Paradigm

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Problem Statement

Recent studies conducted in the field of surgical competency suggest that a large population of graduating surgical residents are not competent enough to perform important surgical procedures independently.

- A study done in 2017 indicated that only 80% of general surgery residents achieved competency based on measures of performance and autonomy in the final six months of residency (George, 2017).
- Achieving competency at the end of residency is a critical component of the healthcare system, as residency can often times be the last step of medical training before students become practicing physicians.

Pathway to become a doctor

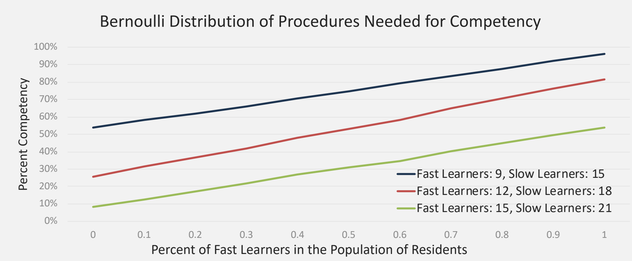
The current paradigm implemented in surgical residency programs is based on the Halstedian model, which states that residents must have repetitive and intensive opportunities throughout residency, as well as graduated independence and responsibility over time, to achieve competency by the end of residency (George, Dunnington, & DaRosa, 2018). This competency model, however, fails to consider several factors that may contribute to incompetency:

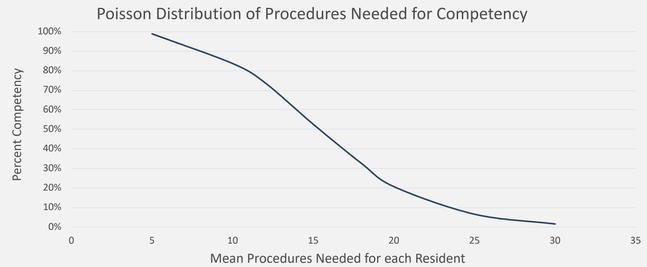
- lack of autonomy granted by attending surgeons
- lack of standardized performance assessments
- stochasticity of procedure arrival rates
- stochasticity of procedure complexity
- differences in resident learning curves
- learning transfer across procedures

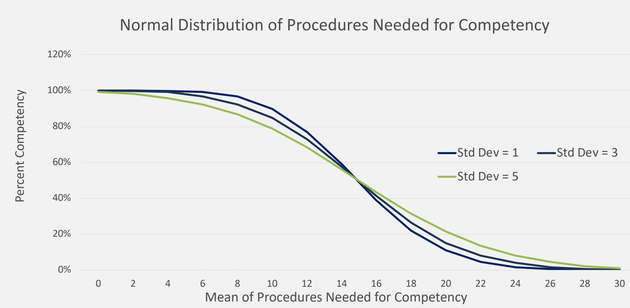
Solution Approach

To better understand the influence of factors such as procedure stochasticity on competency, a simulation tool is being developed to measure effects of these factors on competency of computer-generated residents. These models account for stochastic procedure arrival rates and procedure needed rates per resident, and output competencies based on these inputs.

VARYING DISTRIBUTION OF RESIDENT LEARNING CURVES

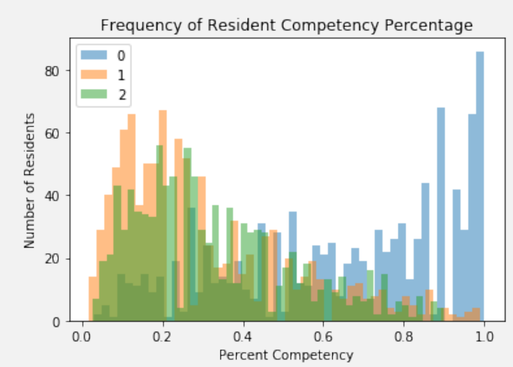






The graphs to the left demonstrate competency curves based on a varying number of procedures *needed* to be deemed competent in performing that procedure and a varying number of procedures *arriving* at a given time. These curves were developed based on number generations in Excel and answer the following question: Assuming the number of procedures per month follows a Poisson distribution centered around a mean of 15, how does resident competency change based on distribution of learning curves?

PERCENT COMPETENCY ACHIEVED ACROSS MULTIPLE PROCEDURES



The graphs above demonstrate multiprocedural competency percentages for 3 procedures across 1,000 residents based on varying arrival rates and varying learning curves. These plots were developed in Python using data visualization code. For the above graphs, the arrival rates and learning rates for each resident were randomly generated for Procedures 0, 1, and 2.

References

George, B. C., Dunnington, G. L., & DaRosa, D. A. (2018). Trainee Autonomy and Patient Safety. *Annals of Surgery,267*(5), 820-822. doi:10.1097/sla.0000000000002599

George, B. C. (2018). Readiness of US General Surgery Residents for Independent Practice. *Annals of Surgery,267*(3). doi:10.1097/sla.0000000000002656

Impact

By creating simulation tools to study the impacts of competency factors, providers will be able to use their knowledge of these factors to target specific training needs of residency. With enough research conducted in the field, surgical residency programs may be restructured to allow for an increased proportion of graduating surgical residents to reach desired competency rates. In turn, greater competency rates may improve healthcare outcomes.