



Using simulation to explore interactions between workflow, staffing and waiting times in a Hong Kong Emergency Department

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Conflict of Interest



Colin Graham is the Editor-in-Chief of the European Journal of Emergency Medicine and receives a modest annual honorarium for his editorial work

European Journal of

Emergency Medicine





Using simulation to explore interactions between workflow, staffing and waiting times in a Hong Kong Emergency Department

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Our Research Collaborators

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Department of Systems Engineering, Chinese University of Hong Kong



Objectives



- Background
- Simulation Tool
- Simulation Results
- Conclusions





Challenges in the ED





Challenges for EM



- ‘Geriatrification’ of the population
 - 1990s Trainee: Trauma:Medical 50:50
 - 2004 Hong Kong: Trauma:Medical 18:82
 - 2011 Hong Kong: Trauma:Medical 13:87
 - Average age of patients on my EM ward \approx 75 yrs
- The elderly are the biggest users of emergency department services, especially critical care





Challenges for EM



- Increasing access block in many EDs globally
 - Needs recognition that this is a hospital problem
 - We need to recognise that ED access block has major impacts on new patient care too
- Critical care access block has a negative impact on care of all ED patients
 - How many of you have ventilated a patient in the ED for >3hrs in the last 3 months?
 - May need to transfer out to another centre





Challenges for EM



- Workforce recruitment and retention
 - Lack of interest in emergency medicine as a career
 - Long and antisocial hours
 - Poor opportunities for private practice
 - Intensity of work
 - Resident trainee recruitment can be very difficult
 - Lack of emergency physician retention
 - Many trainees quit in middle of training program
 - More lucrative opportunities in other specialties





Challenges for EM



- Ever present threat of new infectious disease
 - We are the front line - literally
 - Patients want ED doctors, ED nurses and ambulance personnel – they trust us
 - Avian flu, H7N9 and MERS are stark reminders
- SARS and MERS are direct threats to ED staff
 - First HCW infected with SARS was ED triage nurse
 - MERS remains a major problem in Saudi Arabia





Aims of the Project



- Measure and analyze **patient flow** and **throughput**
- Develop a **simulation model** to represent the patient flow and processes of the Emergency Department
- Evaluate **possible changes** in the processes or space-layout that might enhance the system
- Improve utilization of clinical and human resources and **improve the patient experience**





Why Simulation?



- Analytical models are difficult to build and analyze due to **complex systems and their interactions**
- A simulation approach can incorporate **uncertainty** into the model
- It is easy to **examine many “what-if” scenarios** and identify **bottlenecks** in the system
- It provides a way to **explore possible changes** without jeopardizing patient care
- **Statistical analysis** is easier to perform





Simulation Tool

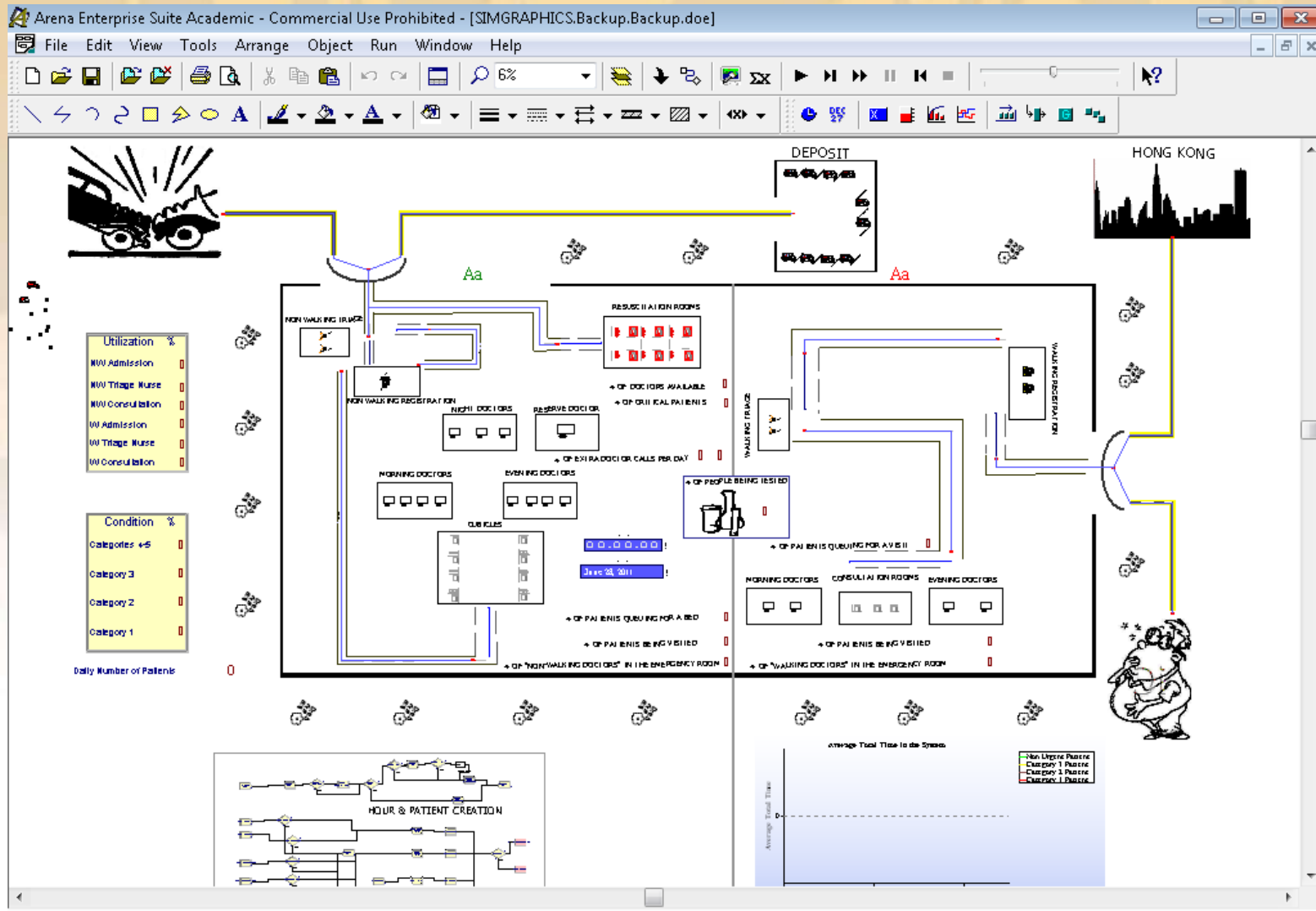


- We captured all relevant **treatment processes**
 - Triage
 - Consultation
 - Lab tests and imaging
- The standard input parameters are
 - Time-varying patient arrival rates
 - Service-duration probability distributions
 - Available resources
- The outputs are key performance indicators
 - Patient waiting time
 - Queue lengths
 - Doctor utilization



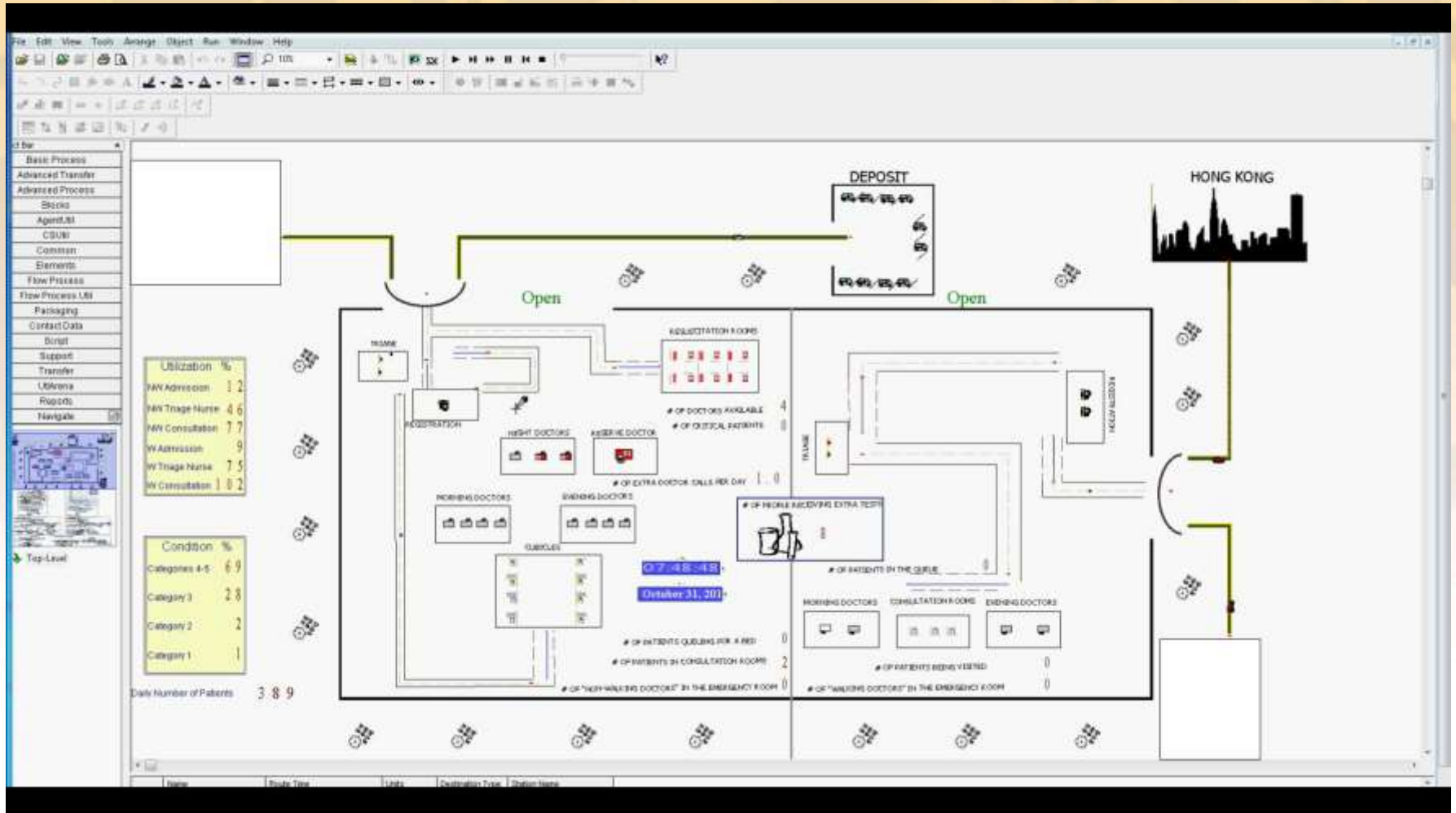


Simulation Tool





Tool in action

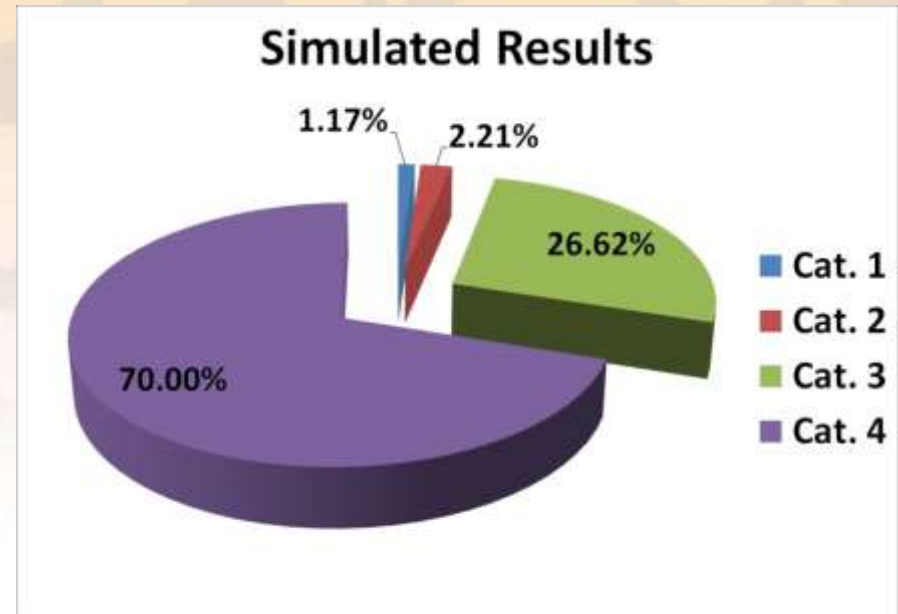
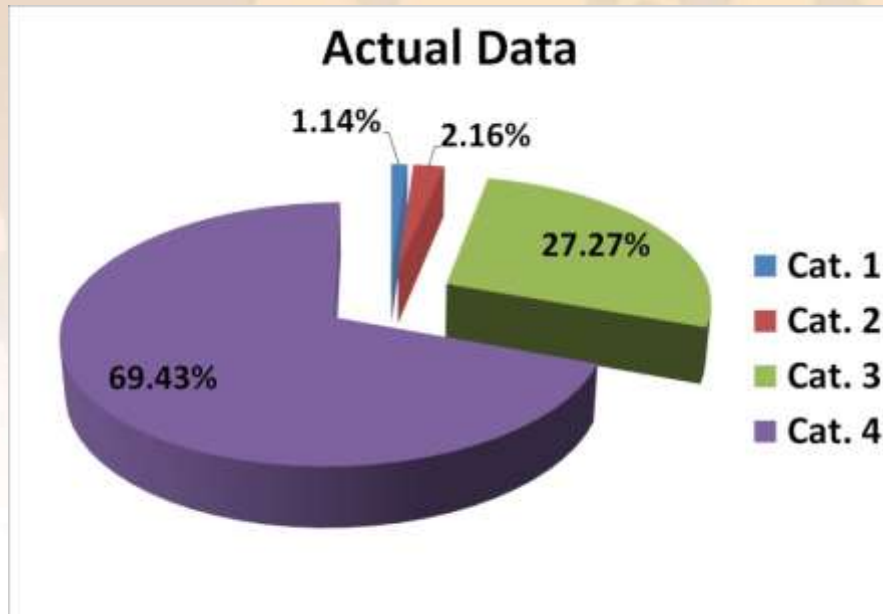




Model Validation



Proportion of patients in each category

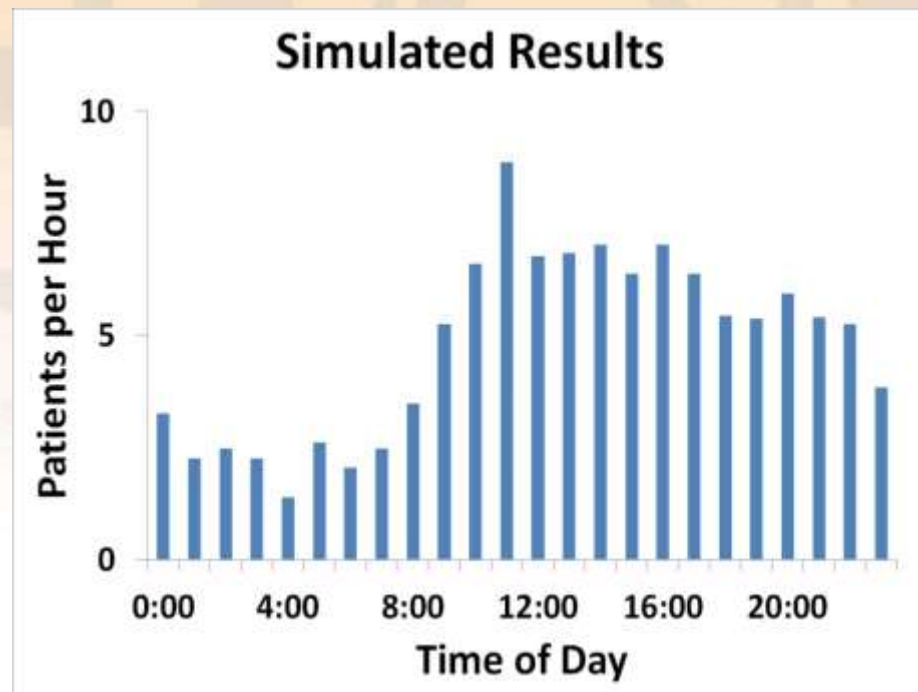
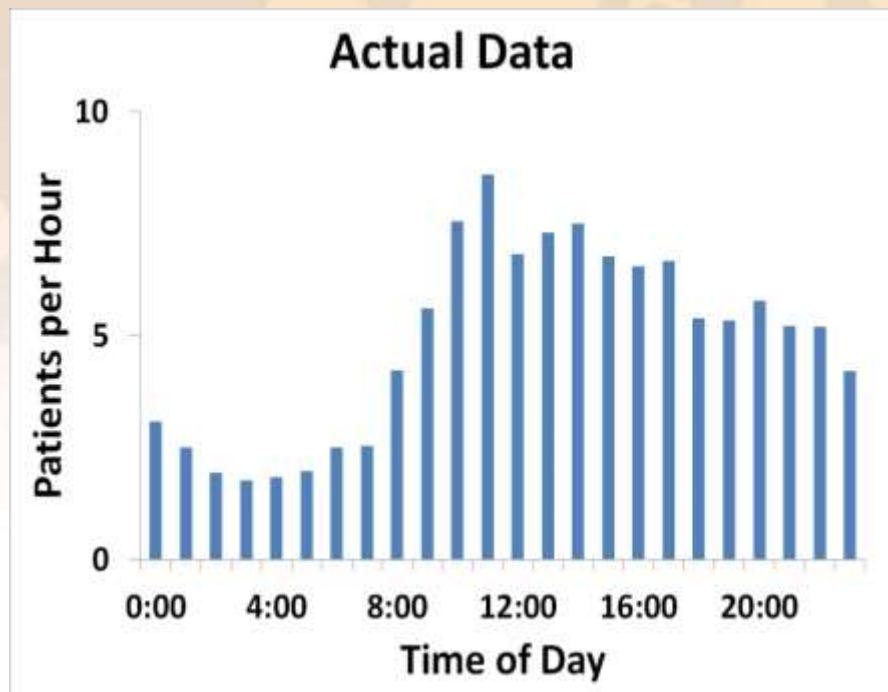




Model Validation



Category 3 patient arrivals per hour by time of day



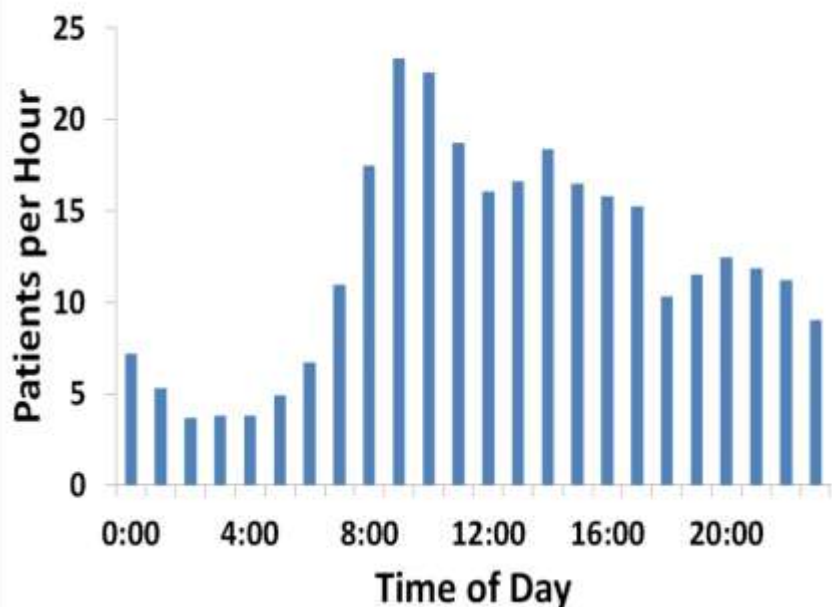


Model Validation

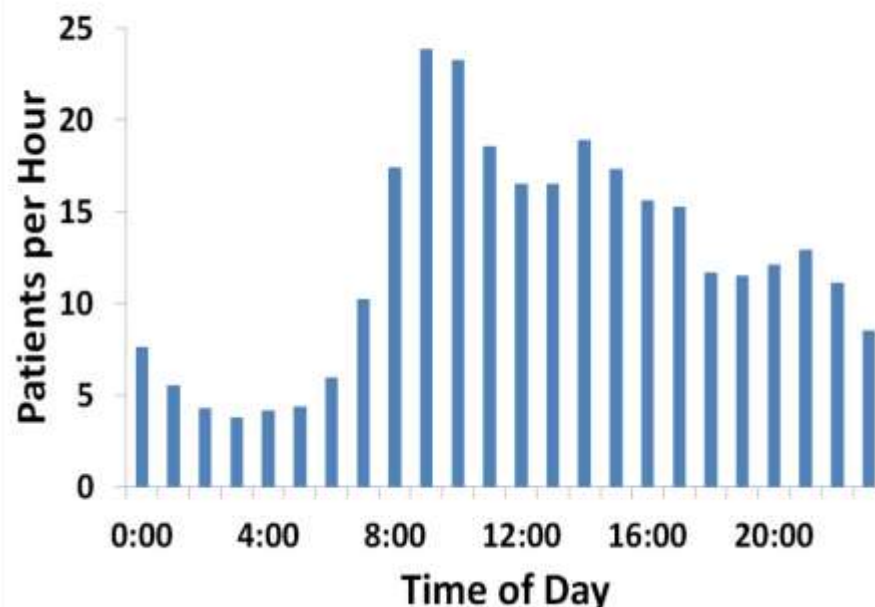


Category 4 patient arrivals per hour by time of day

Actual Data



Simulated Results

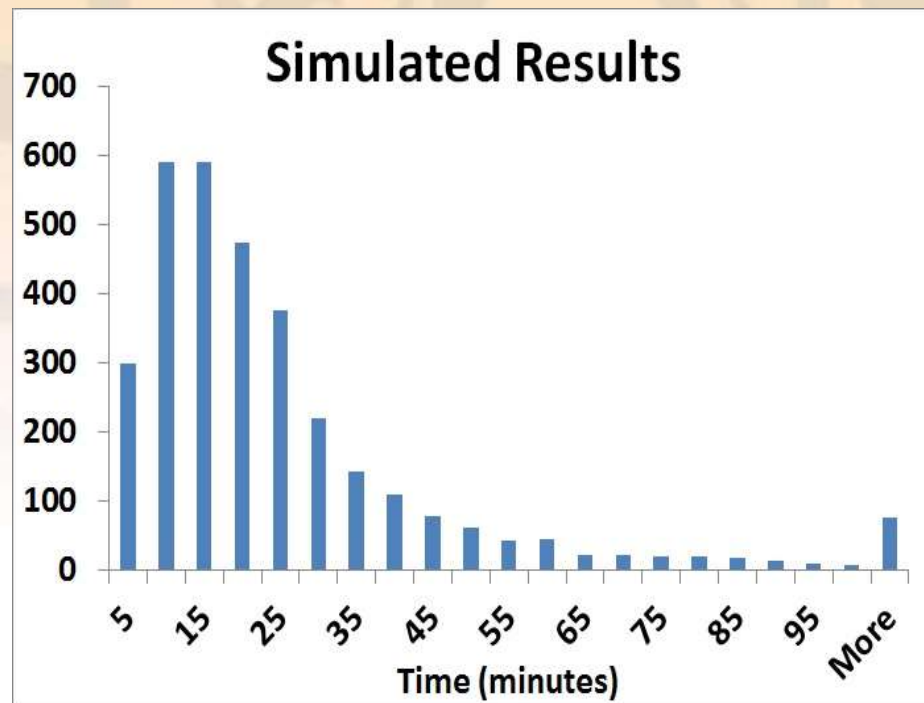
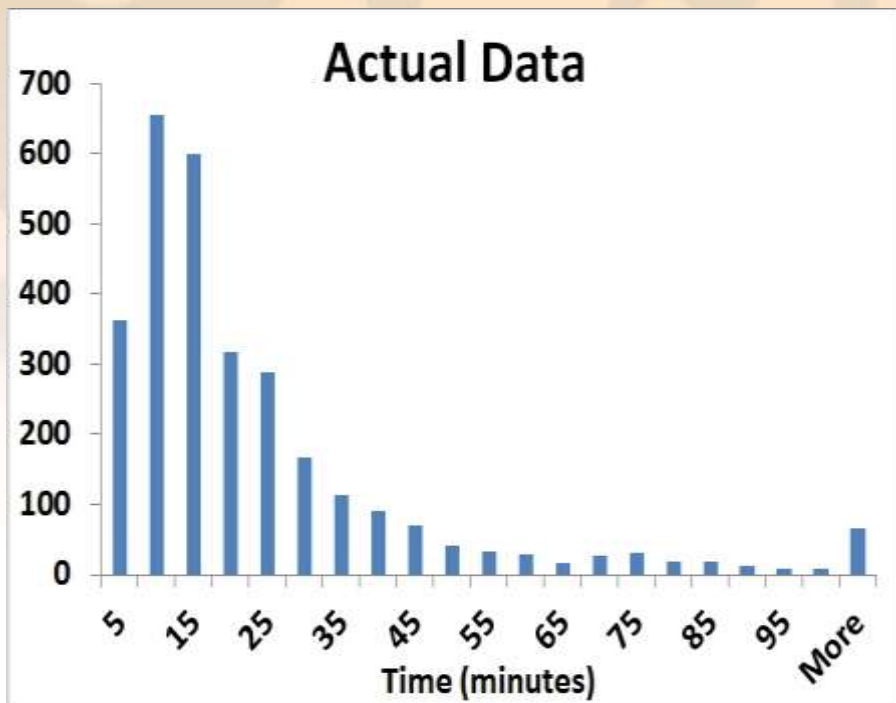




Model Validation



Category 3 patient net time from triage to consultation



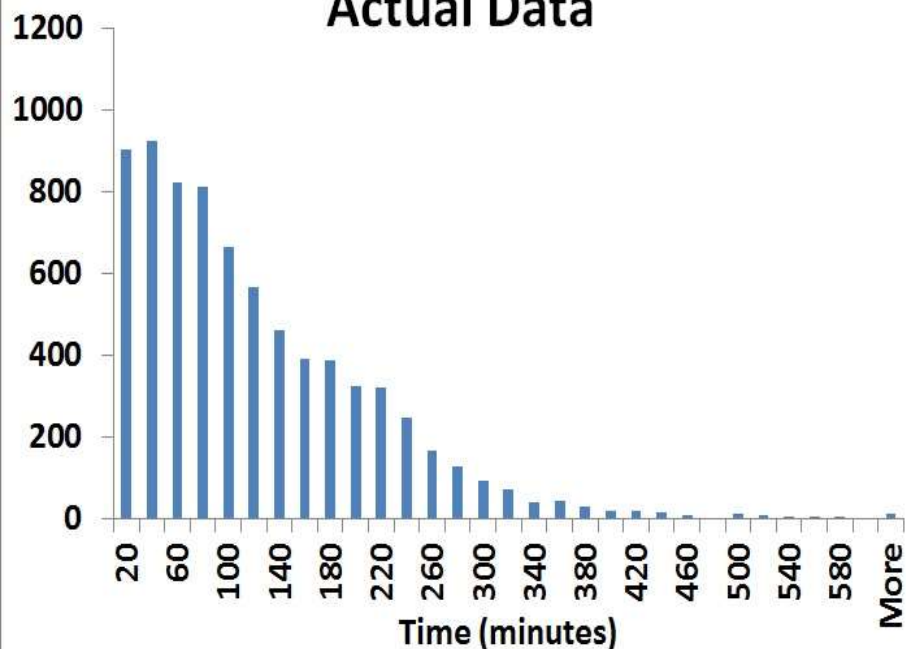


Model Validation

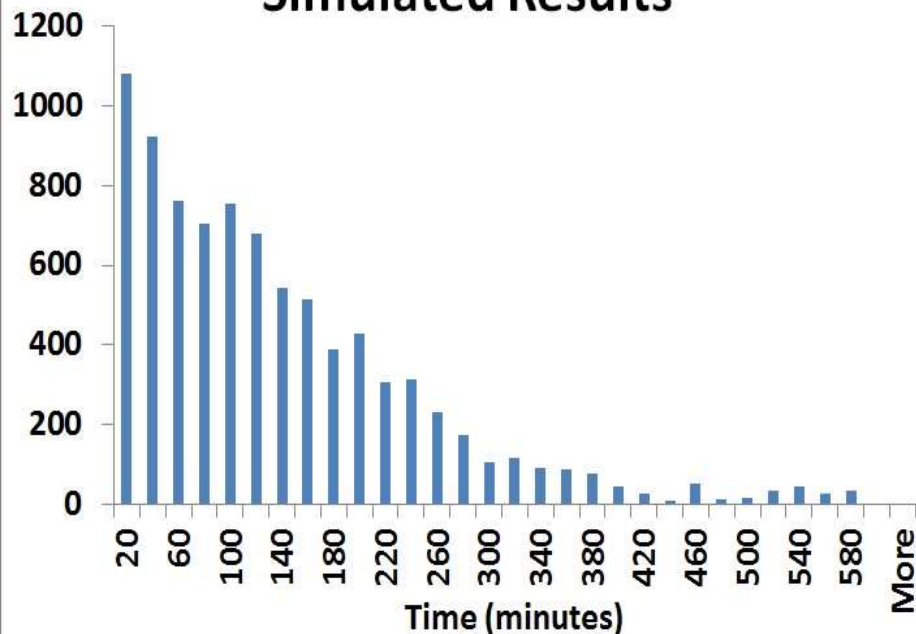


Category 4 patient net time from triage to consultation

Actual Data



Simulated Results





Simulation Results



- We used our simulation model to evaluate the impacts on the system by making **possible changes**
- We investigated the following scenarios
 - Increase the arrival rates of patients
 - Add an extra doctor
 - Change in the proportion of follow-up patients





Simulation Results



- An increment of **10% in arrival rates** leads to increases in
 - Net time from registration to consultation (min)

Category	Current	10% increase	% change
3	21.31	37.44	+75.69%
4	142.53	295.64	+74.01%





Simulation Results



- An **additional doctor** in the walking division for the afternoon shift leads to decreases in
 - Net time from registration to consultation (min)

Category	Current	Additional Dr	% change
3	21.31	20.97	-1.61%
4	142.53	82.16	-50.71%



Simulation Results



- 20% increase in the **follow-up patients** leads to increase in
 - Net time from registration to consultation (min)

Category	Current	20% increase in follow up patients	% change
3	21.31	21.88	+2.66%
4	142.53	173.20	+21.52%



Simulation Results

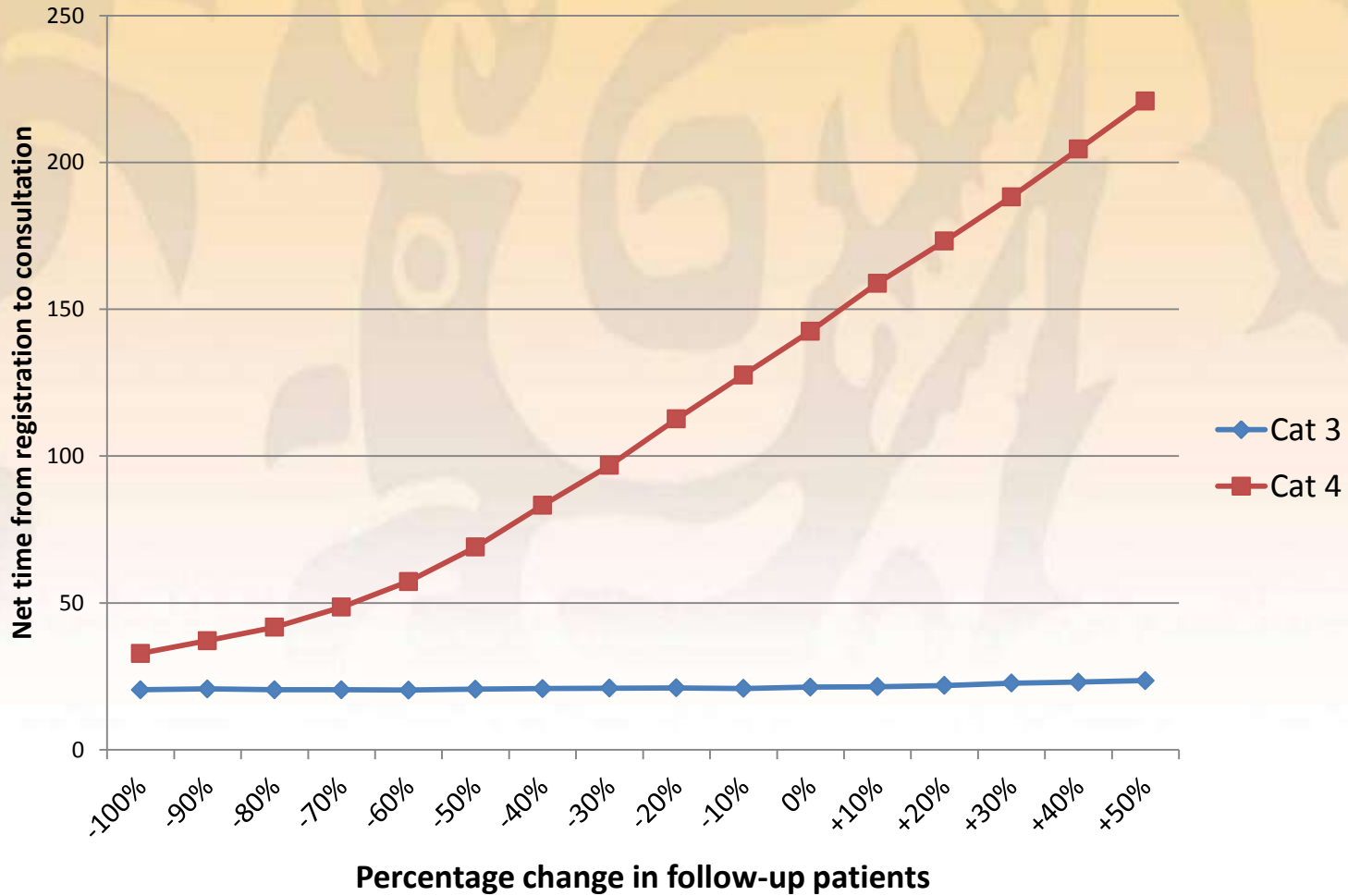


- If there were **no follow-up patients**, there would be decrease in
 - Net time from registration to consultation (min)

Category	Current	No follow-up	% change
3	21.31	20.44	-4.08%
4	142.53	32.82	-76.97%



Simulation Results





Conclusions



- We built a simulation model to represent the daily operations of one Hong Kong Emergency Department
- The simulation model can evaluate impacts on the system by making possible changes in the virtual environment
- It can help the Emergency Department with evidence based decision making





Controversies



- Is the model perfect?
 - Of course not!
- What else needs to go into the model?
 - Time points – RFID technology would be helpful
 - We may be able to learn from billing systems in North America for patient time tracking





The future



- We need to refine the model with more data and better time estimates for the patient care journey
- We need to evaluate other possible changes to make ED care more efficient





Current work



1. Using Simulation to Examine the Effect of Physician Heterogeneity on the Operational Efficiency of an Overcrowded Hospital Emergency Department
2. How Do Missing Patients Aggravate Emergency Department Overcrowding? A Real Case and a Simulation Study
3. Embracing Big Data for Simulation Modelling of Emergency Department Processes and Activities

Reference (2014)

Flex Serv Manuf J
DOI 10.1007/s10696-014-9198-7

Improving the efficiency of a hospital emergency department: a simulation study with indirectly imputed service-time distributions

Yong-Hong Kuo · Omar Rado · Benedetta Lupia ·
Janny M. Y. Leung · Colin A. Graham





Questions ?

