Design for Six Sigma in Disaster Medicine Curriculum Development for Emergency Medicine Residents

Jeffrey Michael Franc, MD, MS(Statistics), MSc(Disaster Med), Dip Sport Med,
Sandy Dong MD, MSc, FRCPC, DABEM,
Colleen Kjelland, MD, FRCPC,
Angela Naismith, MD, CCFP.EM,
Darren Nichols, MD, CCFP.EM,
Manuela Verde, MD, Msc(Disaster Med)

Executive Summary

- At present there is no consistently implemented Disaster Medicine training for Emergency Medicine Residents at the University of Alberta.

- A trial curriculum was created from survey data from residents and results of a disaster medicine pretest. It is composed of four parts:

1. Computer simulation in hospital disaster response
2. Optional seminars with a disaster medicine teacher
3. Yearly presentation on disaster medicine topics at Grand Rounds
4. A series of self-study modules based on examination questions

- The program is administered longitudinally through the third year of residency for residents of both emergency medicine programs with no need to reduce time spent in other rotations.

- Following a trial year of the curriculum, there was a statistically significant increase in resident satisfaction with the disaster medicine component of their residency training.

- Among residents who partook in the trial curriculum there was a statistically significant increase in their exam scores following the training year.

- The trial year exposed several logistical issues with administration of the problem that should be easily addressed for future years.

- The trial curriculum appears to be an overall success, and it is recommended that the program be implemented on a continuous basis

Introduction

Although disaster medicine may be an important part of residency training in emergency medicine, many residency programs do not have a structured disaster medicine curriculum. The University of Alberta is home to two large residency programs: accredited by the Royal College of Physicians and Surgeons of Canada (RCPS), and the Canadian College of Family Physicians (CCFP.EM). A previous research study performed at the University of Alberta and published by the same author detailed a suggested curriculum for emergency medicine residents. [1] However, the program was not being consistently implemented as it was found to be cumbersome to implement. Furthermore, resident satisfaction with the program was unknown. Rather than simply designing a curriculum by consensus, use of the design for six sigma business process management technology – which emphasizes creation of product solution based on customer needs –was chosen to allow a more structured approach to curriculum design. The present study describes the use of design for six sigma to create a disaster medicine curriculum for emergency medicine residency training.

Define

During the Define phase, the author met with the two program directors in Emergency Medicine. Details of the existing residency program training were reviewed. Both program directors felt that there was significant room for improvement in the disaster medicine curriculum. In addition, several design limitations for the new program were discussed. The program directors of both programs were concerned that the disaster medicine curriculum be administered at the same time as other rotations (longitudinally) so that no time was taken away from the residents' previously established learning opportunities. In addition, the design team wanted to ensure that the product was adequately focused on the residents' perceived needs. A project charter was drafted and a RACI matrix was developed. (Appendix 1)

As the project was started in October 2011, and the Academic year runs from July 1 to June 30, there was ample time to schedule the project to enter the verification phase for July 1, 2012.

As the project members do not work physically in the same site, an Internet based project management software Basecamp was used as the focus of communication. This allowed members to communicate with minimal effort and provided a space for file storage and information sharing.

Approval for the project was sought from the Research Ethics office at the University of Alberta. As the project was classified as an educational quality improvement project, and results were presented in aggregate only with no identifying features, the project was approved by the Research Ethics Office without need for formal ethics approval application.

Seven residents of the two residency programs attended a focus group to reveal their initial impressions of their needs for a disaster medicine curriculum. [2] The purpose of the focus group was to elicit the basic, differentiating, and exciting needs of the residents. The focus group revealed that residents feel disaster medicine training is important and should receive more emphasis during the residency program. They also voiced a strong preference for independent study and a focus on exam preparation.[1] Details of the residents' ideas were mapped to an affinity diagram. (Figure 1)

[1] The focus group methodology and results have been previously submitted for course credit towards a MS degree in Applied Statistics at the Rochester Institute of Technology

Figure 1

Measure

During the Measure phase, ideas from the focus group were used to create a survey instrument. (Appendix 2) The survey instrument was a combination of open ended and close-ended questions. Questions were formatted as anchored rating scales (Likert), unanchored rating scales, ranking, and simple checkboxes. Twenty residents completed the survey instrument.

In addition, twenty-one residents completed a pre-test in disaster medicine to determine which areas were common gaps in knowledge. Pretest topics were chosen to correspond with previously published guidelines for disaster medicine curriculum for Canadian medical students. [3]

Analyze

Results from the survey and pretest were entered into a MySQL database for further analysis and analyzed using R.

Results of the survey to 20 residents confirmed that the residents felt disaster medicine to be important. 95% of residents agreed that disaster medicine training was important to them: for exam preparation (100%), for practice in the emergency department (90%) and for future careers (90%).

In general however, few residents agreed that they were well prepared for a disaster (19%) or that their department was well prepared for a disaster (24%). Furthermore, only 33% agreed that disaster preparedness was a high priority at their University.

Median overall satisfaction with the current disaster medicine program was 4 on a seven-point scale. Median satisfaction with the amount of time spent in grand rounds was 3/7. Median satisfaction was 4/7 for both the amount of time spent in independent projects and computer simulation.

In the needs survey, residents voiced a strong preference for four type of learning activities: computer simulation, seminars with a disaster medicine instructor, lectures, and sample exam questions. (Figure 2)

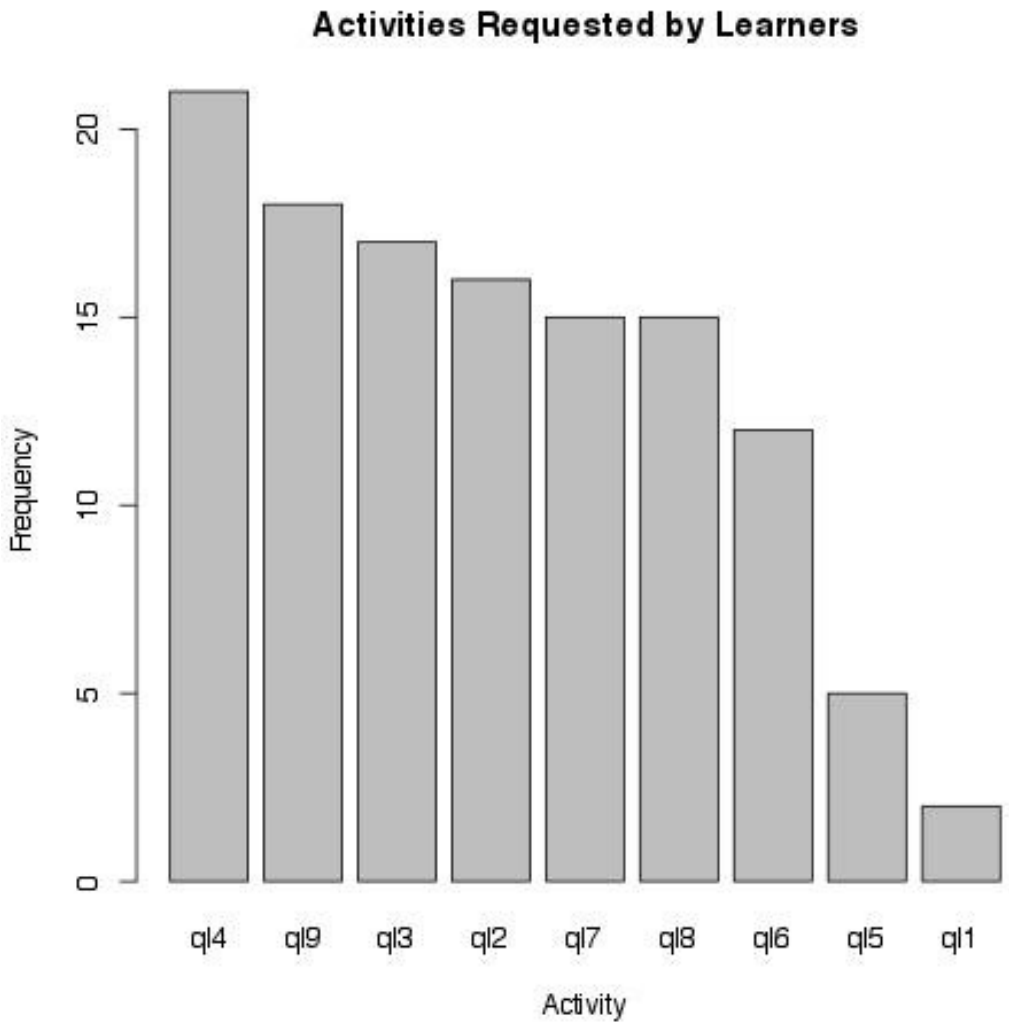

Figure 2

Legend

Ql4 – Computer Simulation
Ql9 – Seminar
Ql3 – Lectures
Ql2 – Exam Questions
Ql7 – Tour of Facilities
Ql8 – Small Group Sessions
Ql6 – On Call for MCI
Ql5 – Group Project
Ql1 – Independent Project

Residents chose the topics of medical management, disaster management, and hospital disaster plans as the most important topics to be included in the curriculum. (Figure 3)

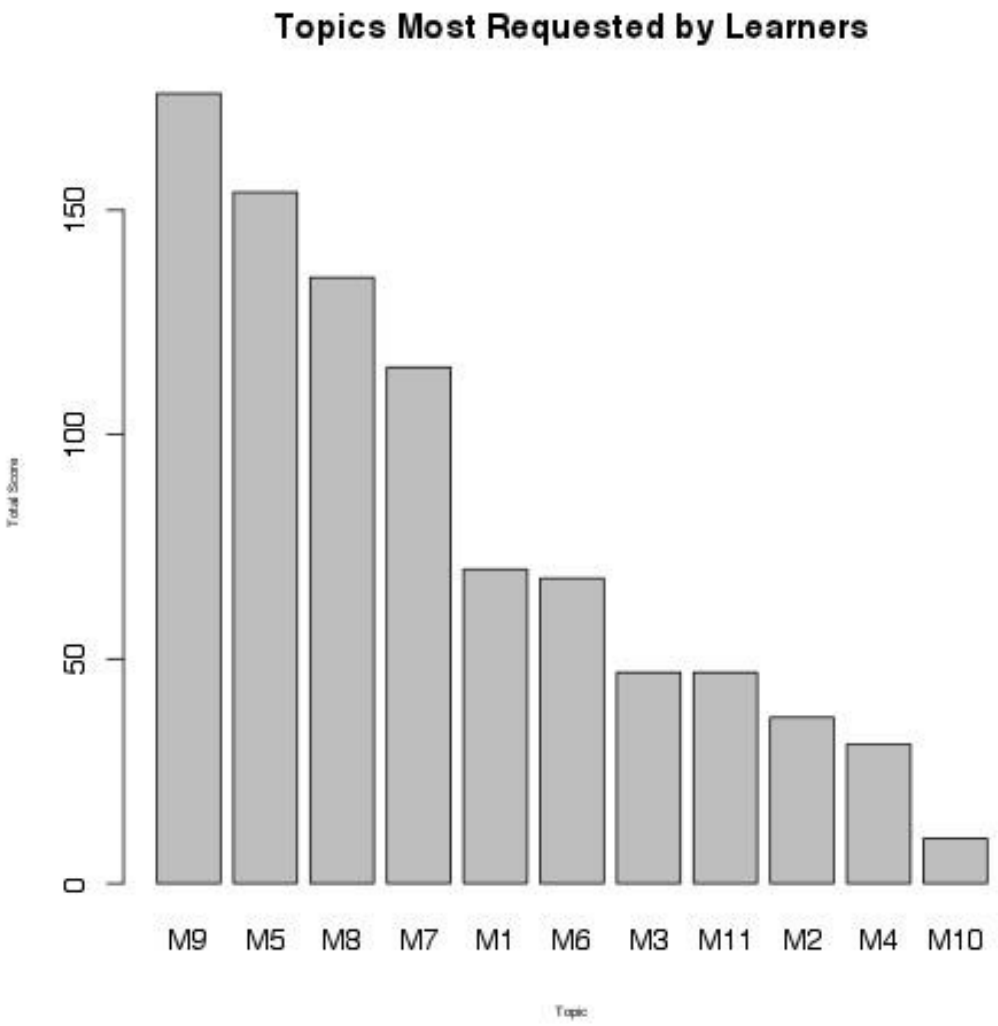

Figure 3

Legend

M9 – Medical Management
M5 – Disaster Management
M8 – Hospital Disaster Plans
M7 – EMS Disaster Response
M1 – Definition of Terms
M6 – Risk Analysis
M3 – Description of Disasters
M11 – International Disasters
M2 – Philosophy of Disasters
M4 – Historical Perspectives
M10 – Psychological Aspects

Overall pretest mean score was 37.5/63 (59.5%). Range of pretest scores was from 31.5/63 (50.0%) to 44.3/63 (70.3%). Pretest scores were highest for the topics of disaster management, definition of terms, and risk analysis, while

scores were lowest for the topics of historical perspectives of disasters, psychosocial aspects of disasters, and philosophy of disaster medicine. A ranking of lost opportunities on the pretest are presented in Figure 4.

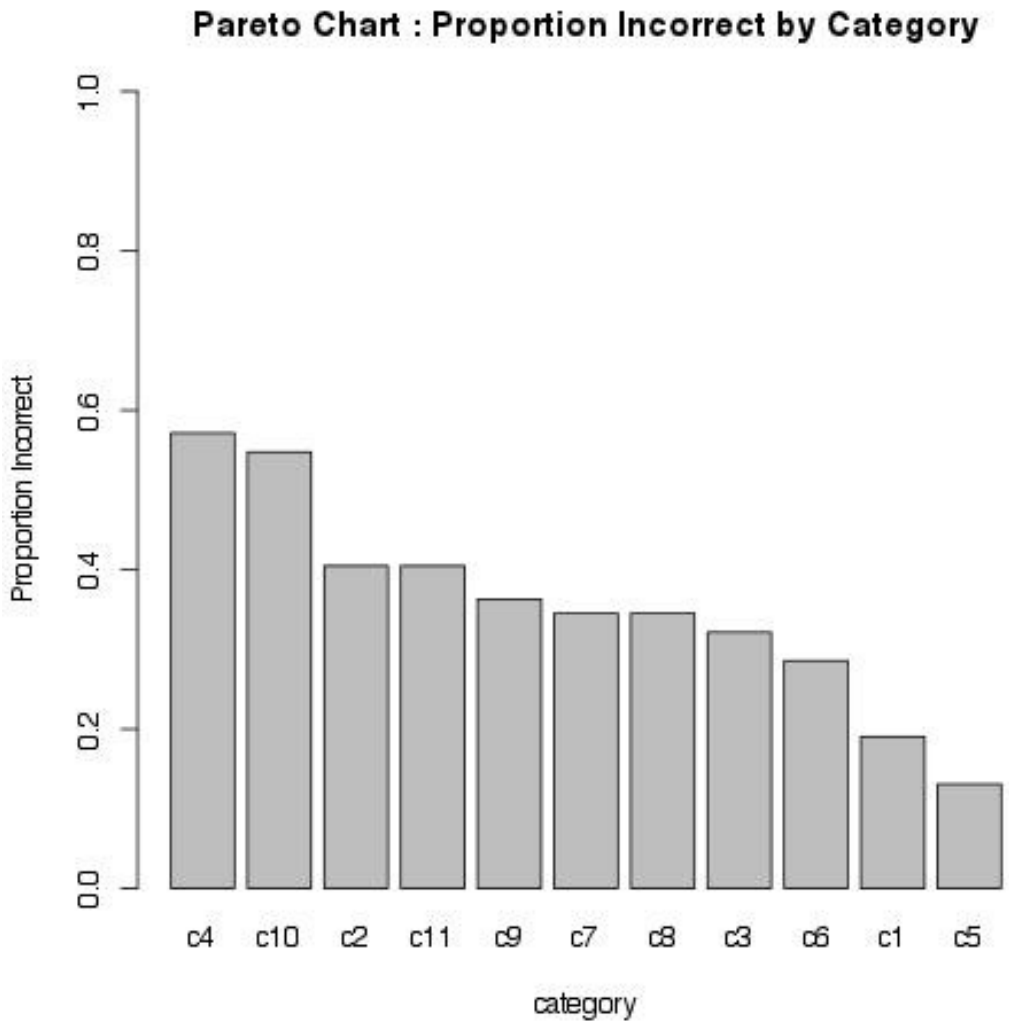

Figure 4

Legend

C4 – Historical Perspectives
C10 – Psychological Aspects
C2 – Philosophy of Disasters
C11 – International Disasters
C9 – Medical Management
C7 – EMS Disaster Response
C8 – Hospital Disaster Plans
C3 – Description of Disasters
C6 – Risk Analysis
C1 – Definition of Terms
C5 – Disaster Management

Design

The final curriculum design was based on analysis of the survey and pre-test data. The final curriculum included the four most commonly requested activities: 1) computer simulation, 2) seminars, 3) lectures, and 4) sample exam questions.

In the new curriculum computer simulation was to be performed yearly. Computer simulation is given by the author using the SurgeSim computer simulation software (SurgeSim, Edmonton, AB, Canada). The simulation protocol has been described elsewhere, but in brief; the simulation session is a four-hour session including a lesson on Incident Command System, a tutorial on use of the simulation, a 1-hour group computer simulation of an emergency department response to a disaster, and a short debriefing session. [4-6] Attendance is mandatory for all residents unless they are schedule for academic purposes outside of the city.

Seminars are to be made available to all residents at their request. Seminars were designed to address specific areas as requested by the residents and to provide a simulated oral examination. This component of the curriculum was considered optional, and residents were to contact the curriculum administrator to schedule a seminar if desired.

Yearly lectures in disaster medicine are to be scheduled on a five-year cycle. Lecture content will be focused on those areas that are not covered well by the computer simulation and are of interest of both interest to the students and of practical significance. Examples of topics that will be covered in the lectures include bioterrorism, pandemic influenza, and hazard vulnerability assessment. Lectures are mandatory for all residents unless they are out of the city for academic reasons.

The final component of the curriculum is composed of self-study modules containing sample examination questions. Residents complete these modules in their own time during rotations where the workload allows, such as the Emergency Medical Systems, Trauma, or Anesthesia rotation. Residents are asked by their program directors to contact the curriculum coordinator prior to their rotation to obtain the first module. Each module is then completed by the resident, and returned to the curriculum coordinator. The coordinator will assess the responses and offer feedback, and then foreword

the next module. There are eleven modules in total. Content of the modules was focused on addressing those areas most concerning on the pre-test instrument. Completion of the first six modules is mandatory for all residents, and the remaining five modules are optional.

Verify

Twelve Residents formed the study group for the verification phase. All residents in their third year of the FRCP program or CCFP.EM program were invited to partake in the study. This group was given a presentation on the curriculum and asked to give informed consent for participation in the study. All residents (6 FRCP and 6 CCFP.EM) consented to the study. The residents were also asked to complete a pretest in Disaster Medicine. Mean score on the pretest was 37.6/63 (59.7%). Range of pretest scores was 30.3/63 to 41.8/63 (48.1% to 66.3%).

All four parts of the curriculum were offered during the trial year. Computer simulation was given as per the curriculum protocol. Seminars were offered to all residents, although no resident requested a seminar. As academic presentation on disaster medicine at ground rounds was a component of the program, all residents were invited to attend a 1-hour lecture given by the author about Bioterrorism.

Residents were also asked to complete 6 of the 11 independent study modules. Median number of modules completed was 5 (range: 0 to 6).

The satisfaction survey (Appendix 1) was also given to all residents in all years of both programs the first year of the new disaster medicine curriculum. 21 residents completed the survey. Differences between median satisfaction scores before and after introduction of the curriculum were compared using the non parametric two-sample Wilcoxon Signed Rank Test. [7] [8] [9] There was a significant improvement in median satisfaction score on all four satisfaction questions ($p<0.005$) as shown in Figure 5.

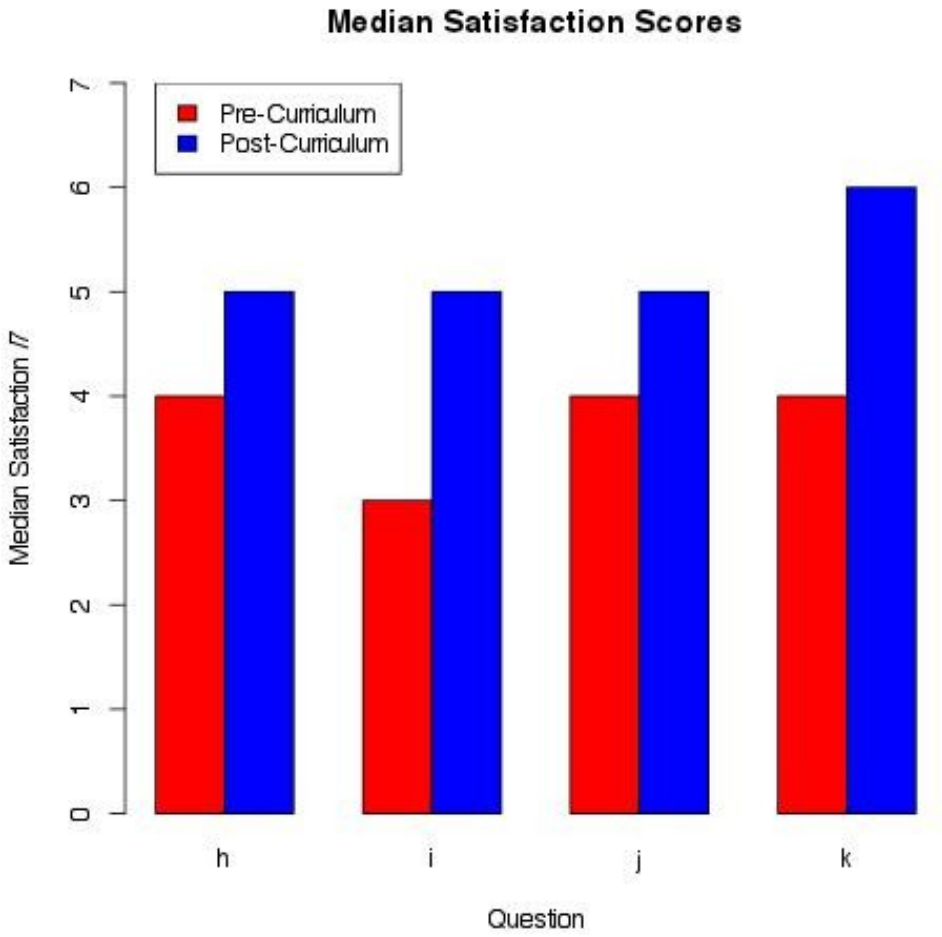

Figure 5

Legend:

H: How satisfied are you overall with the CURRENT DM curriculum?
I: How satisfied are you with the amount of time spent in grand rounds on DM topics?
J: How satisfied are you with the amount of time spent in independent study projects?
K: How satisfied are you with the amount of time spent in computer simulation?

Following the year of training, the twelve residents of the study group performed a post-test. A custom R function was created to compare the pre and post-tests. Mean score on the post-test was 40.2/63 (63.8%) with a range of 36.0/63 to 46.5/63 (57.1% to 73.8%). Using a paired t-test, (there was a statistically significant difference between the pre and post-test scores ($p<0.02$) with a mean difference of 2.65 (95% confidence interval: 0.52 to 4.8).

Limitations

Unfortunately, there are several limitations to the current study.

Firstly, the testing instruments (survey and pre/post test) have never been validated.

Secondly, it is difficult to infer from the results if the statistical increase in satisfaction and exam score are actually significant in a practical sense.

As the study is longitudinal, it cannot prove causality. Proof that the new curriculum is responsible for the increased resident satisfaction and increased exam scores would be better assessed by a randomized trial.

Finally, there were some difficulties in administration of the program that were discovered after the first year of implementation that will need to be rectified. Several residents did not complete all of the six mandatory study modules. In a debriefing session after the trial year, there was some confusion on the part of the residents as to whether the program was mandatory or not; this will need to be clarified by the program directors for subsequent years. As such, several of the residents did not complete all of the required independent study modules. Also, as no residents requested a seminar in the trial year of curriculum, this may require the impetus of the teaching staff to schedule this without waiting for residents' initiative.

Conclusions

Implementation of the curriculum resulted in a statistically significant increase in resident satisfaction and test scoring. Although there are some limitations to the current study, it is recommended that the curriculum be implemented on a continuing basis.

Appendix 1: Project Charter and RACI Matrix

Project Charter
Disaster Medicine Curriculum

Green / Black Belt:	Jeffrey Franc	Organization / Unit:	Emergency Medicine
Process Sponsor:	Dept. of Emergency Med	Completion Date:	Dec 30, 2013

1. Process	Currently residents do not have a well-defined teaching curriculum in disaster medicine. Disaster medicine has been taught at Grand Rounds intermittently. A previous study had shown an increase in resident confidence in disaster management with the implementation of a short curriculum; however, the curriculum has not been followed in the past several years.
2. Problem Statement	Residents require a comprehensive educational experience in Disaster Medicine, however, there is not sufficient time to provide a dedicated block of time for this learning. The design team must create a disaster medicine curriculum that can fit into the present resident schedules and provides opportunities that are educational to the residents and provide resident satisfaction.
3. Objectives by Indicator	
4. Business Results	The project targets two important results. Firstly, the project aims to improve resident performance on disaster medicine examinations by examining pre and posttest data. Secondly, the project aims to improve resident satisfaction measured by satisfaction surveys before and after introduction of the curriculum.
5. Team Members (Include RACI Below)	Jeffrey Franc Angela Naismith Colleen Ryan Manuela Verde
6. Benefit to Customers	Residents will benefit with improved teaching, as this should lead to better examinations scores, more satisfaction with the program, and increased comfort with disaster medicine management. Residents will also benefit in not losing any of the current teaching activities already scheduled in their programs. Program directors will benefit by knowing in advance what content in disaster medicine will be given to the residents. This will facilitate much easier scheduling of resident activities and teaching staff. Teaching staff will benefit in that their roles in the teaching of disaster medicine will be clarified.
7. Schedule	
8. Support Required	-The project will use the *Basecamp* online project management software. -Assistance with photocopying and printing of teaching material will be needed from the department -A large room will need to be booked for the computer simulation -All project members will be needed to help with the computer simulation
9. Special Considerations	The project will need to be discussed with ethics at the University (although it is likely to be exempt)

	Indicator	Baseline	Ideal	Target
1	Resident performance on Exams	Unknown	Improved	
2	Resident satisfaction with Teachings	Unknown	Improved	

Phase	Start Date	End Date	Comment
Project Charter	Oct 1, 2011	Oct 15, 2011	
DEFINE	Oct 15, 2011	Oct 30, 2011	
MEASURE	Nov 1, 2011	Nov 30, 2011	
ANALYZE	Dec 1, 2012	March 30, 2012	
DESIGN	March 30, 2012	June 30, 2012	Time Not critical. Must await next academic year
VERIFY	July 1, 2012	June 30, 2013	(1 academic Year)

R A C I Matrix

	Task	Date Due	Jeffrey	Angela	Colleen	Manuela	Name:_____	Name:_____	Name:_____	Name:_____	Name:_____
1.	Completion of Project Charter	October 15, 2011	R	C	C						
2.	Final Version of Pretest Tool	October 30, 2011	A	I	I	R					
3.	Final Version of Survey Tool	October 30, 2011	A	I	I	R					
4.	Administration of All pretest and surveys	November 30, 2011	A	R	R						
5.	Correction of Pretests Enter Pretest into Database	March 15, 2012	A	I	I	R					
6.	Enter Survey Results into Database	March 15, 2012	A	I	I	R					
7.	Completion of Final Design for Curriculum	June 30, 2012	R	C	C						
8.	Pre-Test for Verification Phase	July 31, 2012	R	C	C						
9.	Administration of Curriculum Presentation at Rounds Computer Simulation Seminars	June 1, 2013	R	I	I						
10.	Post Test for Verification Phase	June 18, 2013	R	C	C						
11.	Post Survey for Verification Phase	June 18, 2013	R	C	C						
12.	Final Report Due	Dec 30, 2013	R	C	C	C					

R: Responsible (Performs the Task)
A: Accountable (Ultimately Answerable for the Activity)
C: Consultant (Input Required Prior to the Action)
I: Informed (Must be Informed After the Action is Complete)

Appendix 2: Survey Instrument

Needs/Satisfaction Survey
Disaster Medicine Curriculum

You have been asked to provide your feedback so that the Disaster Medicine Curriculum can be improved. Your feedback is anonymous, and you do not need to put your name on the survey.

Part I

For the following questions, please pick a number from the scale to show how much you agree or disagree with each statement and write it in the space.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

A) _____ Disaster Medicine training is important for me
B) _____ Disaster Medicine training is important for exam preparation
C) _____ Disaster Medicine training is important for practice in the emergency department
D) _____ Disaster Medicine teaching is important for my future career
E) _____ I am well prepared for a disaster
F) _____ Disaster Preparedness is a high priority at the University of Alberta
G) _____ My department is well prepared for a disaster

Part II

For the following questions, please rate your satisfaction on the following scale

1 2 3 4 5 6 7
^ ^
Not at All Satisfied Very Satisfied

H) _____ How satisfied are you overall with the CURRENT DM curriculum?
I) _____ How satisfied are you with the amount of time spent in grand rounds on DM topics?
J) _____ How satisfied are you with the amount of time spent in independent study projects?
K) _____ How satisfied are you with the amount of time spent in computer simulation?

Part III

I believe the following activities should be part of the curriculum (check any that apply)

L1) __ Independent Study Project

L2) __ Sample Exam Questions

L3) __ Lectures

L4) __ Computer Simulation

L5) __ A Group Project

L6) __ On call for MCI or disasters

L7) __ Tour of existing facilities

L8) __ Small Group Sessions

L9) __ Seminar with Disaster Medicine Instructor

L10) __ Other (Please Specify)

Choose at least five topics that you believe should be part of the DM curriculum, and rank them 1 to 5 (where 1 is the most important to you). You may rank more than five topics, if you please.

M1) __ Definition of terms

M2) __ Philosophy of Disaster Medicine

M3) __ Description of disasters

M4) __ Historical perspectives of disasters in Canada (including pandemic)

M5) __ Disaster management

M6) __ Risk analysis: process and application

M7) __ EMS and disaster response (including ICS, Personal Protection Equipment)

M8) __ Hospital disaster planning and response (including HEICS)

M9) __ Medical management in disaster (including Triage, medical management of specific conditions)

M10) __ Psychosocial aspects of Disaster Medicine

M11) __ International disasters: response and ethics

M12) __ Other (Please Specify)

For each of the following, how many hours ***PER YEAR*** of the Emergency Medicine Curriculum should be devoted to Disaster Medicine:

N1) During Academic Half-day: _____ hours

N2) Independent study during the EMS block: _____ hours

N3) Computer simulation exercise: _____ hours

N4) Live exercises or drills: _____ hours

N5) Small group session or seminar: _____ hours

O) Would you be interested in attaining certification in Incident Command System (I-100)? (This would require a 1-hour lesson, approximately 4 hours of independent study, and an open book exam) (Y / N)

Part IV
Please tell us a little about yourself

P) Residency Program (circle): RCPSC CFPC

Q) Year of Training (circle): R1 R2 R3 R4 R5

Which of the following did you attend in the present academic year?

R) ____Grand Rounds on Disaster Medicine Topic

S) ____Disaster Medicine Computer Simulation

T) ____Self Study Disaster Medicine Modules (# of modules completed ____)

Disaster Medicine Teaching Module Sample Exam Questions

I) Medical Management

A) Describe the START triage system by drawing a flowchart.
B) Describe the NATO triage classification categories
C) Describe the following types of blast injury:
   1) Primary
   2) Secondary
   3) Tertiary
   4) Quaternary
D) Describe which type of radiation injuries require decontamination and which do not.
E) List Six CDC Category A biologic agents:
F) For one CDC category A biological agent describe:
   1) Organism
   2) Route of Spread
   3) Vaccines available
   4) Pharmacological treatments available
   5) Potential for person-to-person spread
G) List the three categories of Nerve agents
H) Describe the two major antidotes for nerve agent poisoning and describe briefly the mechanism of action for each.

II) Disaster Management

A) Describe 5 types of disaster exercises. Give one advantage and one disadvantage for each.
B) Obtain the disaster plan for a hospital emergency department. Review the plan and describe 10 strengths and 10 weaknesses of the plan.

III) Hospital Disaster Planning

A) Define surge capacity

B) Describe the five major components of an ICS organization. Provide a brief description of the role of each. Describe the color coding for each component.
C) List 5 characteristics of a good incident commander
D) Define “Chain of Command”
E) Define “Unity of Command”
F) Define “ICP” and “EOC”. Give 3 similarities and 3 differences between each.
G) Define the acronym “HEICS”. Describe its relation to incident command system.
H) List 10 items that should be part of a hospital disaster plan.
I) Describe 5 key components to dealing with media during a disaster
J) Describe ideal span of control for ICS, and how the organization changes to maintain this ratio.

IV) EMS disaster Response

A) Describe the 4 levels of Personal Protective Equipment. Give an example for each level of an exposure situation where this level would be used.
B) Describe three differences between hospital and scene triage.
C) Who is the initial incident commander at a scene response? When can this command be transferred?
D) How do most victims of disaster arrive to medical care? Give 5 suggestions for an EMS system to optimize this.

V) Terminology

A) Define the following terms:
    1) Disaster
    2) Mass Casualty Incident
    3) Terrorism
    4) Risk analysis
    5) Mitigation
    6) Event
    7) Risk

VI) Risk Assessment

1) Describe the components of the SMUG risk assessment tool
2) Apply the SMUG tool to a single hazard at your hospital.

3) What are the advantages and disadvantages of the Kaiser hazard vulnerability tool over the SMUG tool? (list 3 advantages and 3 disadvantages).

VII) Description of Disasters

A) Draw the disaster cycle
B) Is personnel shortage likely to be a limiting factor in North American disaster management? Give a historical reference to prove your position.
C) “Mass evacuation is often a risk in disaster management”. Comment if this is myth or truth. Give a historical reference.
D) In disasters, what are thought to be "communications problems" are often coordination problems in disguise.” Comment. BONUS: Who is responsible for this statement?

VIII) International Disasters and Ethics

A) Define the following:
   1) Justice
   2) Beneficence
   3) Respect for Autonomy
   4) No Maleficence
B) Define:
   1) Refugee
   2) Internally Displaced person
C) Define complex emergency. Give an example

IX) Philosophy of Disaster Medicine

A) Describe 10 ways that disaster management differs from usual function of the emergency medical system
B) Research an important historical terrorist event. Answer the following questions:
   1) Who were the perpetrators?
   2) What were the goals of the perpetrators?
   3) What was the mechanism? (how was the terrorist act committed?)
   4) What was the causative/harmful agent?
   5) Comment on the effectiveness of the act.

X) Historical Perspectives

A) Describe the three major pandemics in the last 150 years? What was the causative agent? How many people were victims? Was a vaccine available?
B) What are the WHO levels of pandemic? Describe each.
C) What is the causative agent for human pandemics? Describe what makes this agent particularly likely to cause pandemic?
D) Describe the role of vaccine and antivirals in the early phases of a pandemic.

XI) Psychological

A) Define primary, secondary, and tertiary psychological victims of disaster.
B) List 10 common psychological responses to disaster.
C) List the three groups of symptoms for PTSD.
D) Define “Critical Incident Stress Management”.
E) Describe 5 features that should be included in a debriefing.

References

1. Franc JM ND, Dong S: Increasing Emergency Medicine residents' confidence in disaster management: Use of an Emergency Department simulator and an expedited curriculum. Prehosp Disaster Med 2012;26:31-35

2. Franc JM: Customer Needs Focus Group: Education in Disaster Medicine for Emergency Medicine Residents. 2011. http://www.medstatstudio.com/studies/dm_needs.pdf Accessed December 10, 2013.

3. Cummings GE, Corte FD: Designing a curriculum in disaster medicine for Canadian medical schools. International Journal of Disaster Medicine 2004;2:135-147

4. Franc-Law JM, Bullard MJ, Della Corte F: Accuracy of computer simulation to predict patient flow during mass-casualty incidents. Prehosp Disaster Med 2008;23:354-360

5. Franc-Law JM, Bullard M, Della Corte F: Simulation of a hospital disaster plan: a virtual, live exercise. Prehosp Disaster Med 2008;23:346-353

6. Franc-Law JM, Ingrassia PL, Ragazzoni L, Della Corte F: The effectiveness of training with an emergency department simulator on medical student performance in a simulated disaster. CJEM 2010;12:27-32

7. de Winter JCF, Dodou D: Five-point Likert items: t test versus Mann-Whitney-Wilcoxon. Practical assessment, research & evaluation 2010;15:1-12

8. Knapp TR: Treating ordinal scales as interval scales: an attempt to resolve the controversy. Nursing Research 1990;39:121-123

9. Allen IE, Seaman CA: Likert scales and data analyses. Quality Progress 2007;40:64-65