SUBJECT: Third Party Review Report on Additional Costs to EMS Resulting from Hamilton Health Sciences Access to Best Care Plan (HES09002) (City Wide)

RECOMMENDATION:

(a) That the Third Party Report, prepared by Integral Performance Solutions, respecting additional costs to Emergency Medical Services resulting from the Hamilton Health Sciences Access to Best Care Plan (attached as Appendix A to Report HES09002), be received.

(b) That staff be directed to forward the Third Party Report, prepared by Integral Performance Solutions, to the Ministry of Health and Long-Term Care when requesting adjustments to provincial land ambulance grants in order to offset increased costs of new ambulance resources necessary to maintain performance.

(c) That Item “GG” – Third Party Review – Additional costs to EMS Resulting from Hamilton Health Sciences Access to Best Care Plan, be considered complete and removed from the Emergency & Community Services Committee’s Outstanding Business List.

Jim Kay
General Manager / Chief
Hamilton Emergency Services
EXECUTIVE SUMMARY:

In accordance with the Emergency and Community Services Committee (E&CS) Report 08-015, Item 11, the General Manager/Chief of Hamilton Emergency Services (HES) was authorized and directed to hire Integral Performance Solutions (IPS) to complete a Third Party Review of the impacts to the Emergency Medical Services (EMS) Division, stemming from the closure of the McMaster University Medical Centre (MUMC) emergency department to adults, and report back to the E&CS Committee.

The request for a third party review of the Hamilton Health Sciences (HHS) Access to Best Care (ABC) Plan and its impacts on EMS came from Council after they had directed staff to conduct its own review and concluded that the financial impact on the City of Hamilton (City) paramedic service was estimated at approximately $1.4 million of added paramedic service to achieve the same performance in the absence of any other material mitigation interventions by HHS to offset MUMC becoming a paediatric only emergency department.

IPS conducted a more thorough review of the planned MUMC change and the ABC Plan (attached as Appendix A to Report HES09002) and has concluded that it estimates that the financial impact to Hamilton EMS could be $1.5 million. The IPS report outlines a number of recommendations and discussions on pages 12 and 13 of the attached Appendix A.

BACKGROUND:

In 2008, HHS announced its ABC Plan to which Council expressed concern as to how the Plan may impact paramedic service performance. Subsequently, staff conducted a high level review of the ABC Plan; focusing on changes that may be relevant to EMS. Specifically reviewing the need for additional specialization of services at each of the three (3) hospital sites; providing particular attention to MUMC in light of the recent Local Health Integration Network (LHIN) decision to make it a paediatric only emergency department. Consideration was also given to the paramedic requirements that will be needed to service the new HHS urgent care facility, which is being built in the city’s west end.

Staff has estimated that the change to the MUMC emergency department will shift deployment of ambulances to the core of the city, thereby, increasing the time for EMS to complete a large number of calls in the west section of the city. Subsequently, creating an indirect modification to the placement of ambulances, this, in turn, would need to be offset. The staff cost estimate, of $1.4 million, reflects an increase in paramedic resources, if the changes to the MUMC emergency department were to be implemented immediately; with no intervention by the hospitals to mitigate the impacts to EMS.
ANALYSIS/RATIONALE:

Staff should use the IPS Report on the ABC Plan to justify relevant requests for additional provincial grant funding for EMS.

ALTERNATIVES FOR CONSIDERATION:

None.

FINANCIAL/STAFFING/LEGAL IMPLICATIONS:

Financial:
Currently, there are no financial implications associated with this matter. However, IPS predicts that the budgetary impact to Hamilton EMS will amount to approximately $1,524,240 annually once these changes come into effect.

As well, IPS does state that “There are several factors in these findings that can be exacerbated or mitigated by the actions of Hamilton EMS and local hospitals."

Staffing:
There are currently no staffing implications respecting this matter.

Legal:
There are no legal implications associated with Report HES09002.

POLICIES AFFECTING PROPOSAL:

As part of the City’s official Strategic Plan, staff should maximize opportunities to receive grants from other levels of government and to maintain a healthy community.

RELEVANT CONSULTATION:

Hamilton Health Sciences and St. Joseph’s Health Care were provided opportunities for input and verification of the IPS review. A copy of this Report will be circulated to Hamilton Health Sciences and St. Joseph’s Health Care immediately after becoming a public document, and EMS staff will meet with hospital representatives at their earliest convenience.
CITY STRATEGIC COMMITMENT:

By evaluating the “Triple Bottom Line”, (community, environment, and economic implications) we can make choices that create value across all three bottom lines, moving us closer to our vision for a sustainable community, and Provincial interests.

Community Well-Being is enhanced. ☑ Yes ☐ No
The public are involved in the definition and development of local solutions.

Environmental Well-Being is enhanced. ☐ Yes ☑ No
Human health and safety are protected.

Economic Well-Being is enhanced. ☑ Yes ☐ No
A skilled, innovative and diverse workforce is attracted and retained.

Does the option you are recommending create value across all three bottom lines? 
☑ Yes ☐ No

Do the options you are recommending make Hamilton a City of choice for high performance public servants? 
☑ Yes ☐ No
IMPACT OF PROPOSED HAMILTON HEALTH SCIENCES RESTRUCTURING ON HAMILTON EMERGENCY MEDICAL SERVICES
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I. **INTRODUCTION**

Integral Performance Solutions (IPS) was retained by the City of Hamilton to evaluate how the closure of Hamilton Health Sciences’ (HHS) McMaster University Medical Centre (MUMC) to adult patients will impact the services provided by the Hamilton Emergency Medical Services (HEMS).

During a project completed in 2007, IPS was engaged by HEMS to forecast future demand, resource needs, scheduling requirements, and to create a geo-temporal deployment plan that allowed HEMS to deliver timely services throughout its service area. IPS has been asked to reexamine the situation in anticipation of the change at MUMC.

II. **METHODS**

A. **HOSPITAL INPUT METHODS**

In an attempt to forecast future resource needs as accurately as possible, IPS asked local hospitals for the following information:

- From MUMC:
  - Monthly or quarterly ambulance patient and overall ED historical volume by age category for the past few years and projections of the same the next few years forward.
  - Any data/analyses that they may have regarding the consequences of their ED closure and the methods used for their estimation of the impact it may have on HEMS.
  - Their best guess(es) for when the closure would occur and how much notice HEMS might be given beforehand to prepare.

- For the other hospitals, their volume projections for the next few years. Hospitals were asked to mention if the closure of the MUMC site was or was not factored into their projections.

- For all hospitals, any other factors that they thought should be considered in IPS’ assessment of the impact that the change will have on EMS, positive or negative – along with any data associated with those factors as appropriate.

IPS also contacted local hospital representatives by phone. This was done to provide hospitals an opportunity to discuss the impact the MUMC change would have on their operations and factors they felt IPS should consider regarding the impact it will have on HEMS – or any other input they would like to provide.
B. Community Input Methods

IPS was provided access to the “Access to Best Care Plan Evaluation - Research Report” prepared for Hamilton Health Sciences in April 2008 by Leger Marketing (www.legermarketing.com). IPS analyzed the report to determine how the behavior of affected residents might change after the MUMC ED closes to adult patients.

HHS put together a presentation entitled “Access to Best Care” to explain both the reasons for closure of the MUHC and opening of the urgent care centres. The presentation was given by Mr. Martin, CEO of HHS. The Leger’s market research study was conducted to obtain feedback from Hamilton residents on the presentation as well as the changes at MUMC and other parts of HHS. More specifically, the objectives of the research were:

- To obtain the general and honest thoughts and impressions of the overall presentation
- To gauge the reaction and create a discussion of the specific issues presented
- To determine the participant’s general understanding of the implementation for change
- To gauge a focus of communication by probing participant’s on the changes and timeline of the project

Leger Marketing conducted a total of three focus group sessions at the McMaster University Medical Center in Hamilton. All participants were recruited from the Greater Hamilton Area and came from a wide range of socio-demographic backgrounds. Additionally, no participant was employed by Hamilton Health Sciences.

IPS feels that the Leger’s market research study was done in a thorough and sound manner. While the total size of the three groups interviewed might not be big enough to represent a statistically valid sample of the population of the Hamilton metro area, they did screen and selected the participants in a manner to ensure reasonable diversity in the participants.

C. Operational Research Methods

This study builds on operational research analyses and modeling completed for the HEMS project in 2007. The methods used for these prior analyses and the current project are described below.

IPS collaborated with the Dr. Jeffrey Goldberg, Interim Dean of the Department of Industrial and Systems Engineering at the University of Arizona (www.sie.arizona.edu) for several aspects of the prior and current operational analyses.

At a general level, IPS’ deployment and performance modeling for HEMS involved these major steps:

- Developing a clear understanding of the current system’s performance;
- Developing a model of the operations of the system based on the system’s business rules;
- Creating iterative adjustments to the model to enhance its effectiveness at predicting performance accurately and then using the model to give insight on the impact of different decisions.
The original operational analyses and computer models for HEMS (developed for the 2007 engagement) were adjusted for the current project to address changes in emergency department destination, which in turn impacts ambulance task time, which in turn impacts the number of ambulance unit hours to achieve a given level of response interval performance. A secondary analysis was made to estimate the potential impact of the MUMC change on hospital off-load times at the other hospitals.

For the original analysis in 2007, IPS began by reviewing the current deployment strategies with HEMS. Performance measures were created for comparing the outcomes of potential changes.

Data on zone structure, ambulance demand, travel times, service times, and transport times was used to build the computer model that could predict system performance as measured by vehicle utilization; inter-zone pickups; average travel times; and the percentage of calls that do not meet the response interval / reliability requirements. Particular attention was paid in this modeling process to the validation of the output to ensure that the model was predicting reliably and accurately.

The final step involved carrying out iterative experimentation with the model. This allowed IPS to rapidly investigate a wide range of scenarios and various strategies to optimize performance – something that would be impractical with the actual system. This iterative process is depicted in the figure labeled ‘Model Outputs’. Once the reliability of the model was established, it was possible to consider alternative strategies.

**a) Crew Capacity Planning and Scheduling**

The IPS approach to setting crew levels uses queuing theory. Our demand analysis makes an assumption that that calls come to the system are based on a Poisson process. By this method, the probability distribution can be calculated for any number of busy crews and any service time mean (and distribution).

Once the number of crews is determined, then actual crews need to be scheduled to best meet these needs. We used mathematical programming to model the scheduling problem. We scheduled 2 weeks

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1 [http://en.wikipedia.org/wiki/Queuing_theory](http://en.wikipedia.org/wiki/Queuing_theory): Queueing theory is the mathematical study of waiting lines (or queues). The theory enables mathematical analysis of several related processes, including arriving at the (back of the) queue, waiting in the queue (essentially a storage process), and being served by the server(s) at the front of the queue. The theory permits the derivation and calculation of several performance measures including the average waiting time in the queue or the system, the expected number waiting or receiving service and the probability of encountering the system in certain states, such as empty, full, having an available server or having to wait a certain time to be served.

2 [http://en.wikipedia.org/wiki/Poisson_process](http://en.wikipedia.org/wiki/Poisson_process): A Poisson process is a standard method used to model arrivals to a system. It is the result of having a large number of potential customers, N, where each has a small probability, p, of using the system in a short time interval. The product, Np, is called the “intensity of the process” and is the average number of arrivals per unit time.
b) Location Modeling

Once the number of crews was set for specific time periods (by time of day and day of week), plans were created for deploying vehicles over the geographical area in those time periods. IPS used a computer model that simulates the operation of a spatially distributed queuing system to help make those geographic deployment plan decisions.

For each grid/zone, past data was used to estimate demand, call service time (including possible hospital and transport times), and chute times. Also, for each station-zone pair, the travel time and the probability that a call is answered within a set time standard (10:02 minutes for example) were estimated. The model then estimated performance of the system with the following statistics:

- Fraction of time that each vehicle is busy
- Number of calls that each vehicle answers
- Fraction of answered calls that meet the time standard (by vehicle)
- Fraction of calls that meet the time standard (by zone and system wide)
- Fraction of calls that go to a system operating parallel (e.g., mutual aid) due to all vehicles being busy
- Average travel time for each vehicle (based on the calls it answers)

The model we used is based on the ‘Hypercube Approximation Model’ (developed by Dr. Richard Larson at M.I.T. in 1975 and extended by Dr. James Jarvis at Clemson in 1985 and Dr. Jeff Goldberg at the University of Arizona in 1990).

The model can run a variety of station location settings and can adjust for different numbers of stations. Recently, our partners at the University of Arizona have implemented an optimization method in the model code so that it is possible to simply make requests such as “pick the best 20 stations locations out of the 100 possible locations that we are considering”. Varying the number of stations/post locations is critical as this is what is necessary when planning deployment for different periods of the day. Low demand hours may have an entirely different deployment plan and this can only be determined by experimenting with different numbers of stations or posts. This is very different from the ‘system status management’ approach, which uses a simplistic covering method to determine posts when different numbers of vehicles are available. Here, it is possible to easily change the number of posts and determine locations that optimize performance measures that are based on computed busy probabilities. One can use the model to preplan and find the correct set of station locations for any contingency desired.

c) MUMC Change Impact Assessment

For consideration of the potential impact to HEMS that closure of the emergency department at MUMC to adult patients may have, IPS performed the following analyses:

- Estimation of the number of pediatric ambulance transports to MUMC, to include estimation of additional pediatric patients that may be diverted from other hospital EDs to MUMC as a result of its specialization in pediatric emergency care
• Estimation of the number of adult patients that will be diverted from MUMC to other hospitals
• Estimation of the changes in ambulance task time, to include transport and hospital off-load times
• Estimation of the number of additional unit hours needed to compensate for the changes in ambulance task time
• Estimation of the number of additional units needed to provide the additional unit hours
• Recommendations for the timing and placement of additional units / unit hours

We asked HEMS and the hospitals to provide us with the number of pediatric and adult patient transports to MUMC for CY 2007. For the analysis we used the hospitals numbers in our calculations.

Estimation of the changes in ambulance task time was done in two steps.

The changes in ambulance transport and return travel times were calculated by:

• Using an approximation of 10 minutes as an average in added transport time that was applied to the number of adult transport patients that would need to taken to other emergency departments.

• Using an approximation of 5 minutes as an average in added return travel time for the available ambulance to return to reasonable proximity of its primary coverage area and thereby be available for the next call. This 5 minute factor was applied to the task time for number of adult transport cases.

The changes in hospital off-load intervals were examined by regression analyses that contrasted rises in ambulance call volume to hospital off-load intervals.

Adding together the estimated changes in ambulance transport, return travel, and hospital off-load intervals gave us the total estimated change in ambulance task time.

Estimation of the number of additional unit hours needed to compensate for the changes in ambulance task time was made by using computer modeling tools to recalculate the number of additional unit hours that would be needed to maintain emergency response service within 10:02 at a 90% reliability rate. The number of additional unit hours needed to be translated into the number of additional units that HEMS would need to deploy to provide those unit hours. This was done by dividing the aggregate number of units required by the 8 hour time frame used as in development of previous deployment plans. It should be noted that this number may slightly underestimate the number of unit hours needed to operationalize the required increase.

Once we estimated the number of unit hours and units that would be needed, we provided recommendations for the timing and placement of those units. This was done using computer modeling tools to solve for a good set of locations for each level of available units in the system up to the maximum number of units that would be ever be deployed by HEMS for routine scheduled operations. Each such set of locations is called a solution. By building solutions for each level, it is easy for dispatchers and operations managers to move between levels with prompt re-deployment of available units to the appropriate set of locations for that solution. To estimate performance at each level of available ambulances, the fraction of time that the system is in each level is and the success rate for meeting the target response interval (10:02) when the system is operating at that level.
grid success rate is also estimated. This allows the model to estimate the appropriate number of vehicles to deploy in each time interval.

D. Literature Review

A literature search was conducted on the PubMed database of medical, nursing and allied health journal articles (www.pubmed.gov). Keyword combinations were used to look for articles discussing the impact of emergency department closures on the general public and the EMS systems in their catchment areas. A similar keyword search was also conducted for other relevant information outside of the medical literature using the Google search engine.

III. Findings

A. Community Behavior Analysis

Most of the language in this section is taken directly or paraphrased from the “Access to Best Care Plan – Research Report” from Leger Marketing.

Study participants perceived several benefits to the plan that were relevant to the EMS impact issue:

- Turning McMaster’s ED into a Pediatric ED is received with open-arms, especially for those who have children or grandchildren. Even those without children believe the idea to be a positive one. The main benefit is the ability to provide specialized care to children. Also, most feel that a Pediatric ED separate from an adults’ ED will help reduce the wait-times for both children and adults.

- Many feel the addition of an Urgent Care Centre (UCC) is a positive change, as it will reduce wait-times by moving non-urgent cases out of the hospital EDs. However, some, particularly those who have visited the existing UCC in Stony Creek, are skeptical. The skeptics playback experiences where the wait time at the UCC was longer than that at the ED or that the UCC was not open when it was needed. Overall, the idea of a UCC is well received, if it is able to offer the same level of care that is available currently at the EDs.

While feedback was positive overall, some expressed concerns relevant the EMS impact issue:

- What worries participants the most is not knowing which hospital they should go to in case of an emergency and what will happen if they go to the wrong one. People are concerned about the quality of treatment, the wait-times, and if the hospital will transfer them or if they will be refused treatment if they make a mistake in their decision where to go. Some are also concerned with the cost of being relocated (i.e. ambulance fee).

- Residents also feel they need to understand what is considered an emergency to be treated at an ED and what is non-emergent and should be treated at a UCC.

- Uncertainty of the degree to which the UCC will be able to help the community, particularly if it is not available 24/7

- The requirement to travel further in the case of an emergency (only a concern to a minority)
In most cases, communication was expressed as the key to alleviating these concerns. Most feel that if they are given the knowledge of how the changes will affect them, and what they should do in an emergency, they would feel more at ease with the changes being made.

In discussion after one of the formal presentations, Mr. Martin focused attention on the importance of residents calling an ambulance instead of transporting themselves to the hospital. A large majority of the participants, particular those in that group, are extremely confused about this procedure. Most of this confusion stems from the fact that their past experiences with emergency rooms have been in non-life threatening situations. Therefore, they are wondering if they should be calling an ambulance for all situations. Additionally, many mention the cost of ambulances and feel that will be a barrier to their use. Comments from participants included:

- “What about the low income families? How are they going to afford an ambulance?”
- “I hope I make it within the “golden hour”.”
- “So what if I cut my hand, I am supposed to call an ambulance? I don’t get that. I think I would still just drive myself.”

Most participants are not concerned about the distance to travel. They can see the benefit of traveling an extra few minutes, if they are going to receive specialized care when they arrive. There are some older participants who are concerned, however. They believe that the best scenario is to get to the closest hospital as fast as possible and that all hospitals should be able to deal with all situations.

- “I want to get to the hospital as fast as possible. It’s a hospital; they should be able to take care of me.”
- “I would definitely drive, what an extra 10 minutes, to get better care.”
- “It’s only a few more minutes more to get to the next hospital.”

IPS was most interested in how the behavior of affected residents might change after the MUMC ED closes to adult patients. The results of the Leger report strongly suggests:

- Residents who would be currently inclined to drive themselves to the ED will probably not change that behavior as the additional drive time from MUMC to the next closest ED is not that much longer. On that basis, IPS does not anticipate a net change in the number of ambulance transports as a result of the change.

- The public education campaign should clarify which types of problems /symptoms /situations should be seen at the UCC and which should be seen at the ED. For those that should be seen at ED, the education should offer guidance on which cases may warrant transport by ambulance versus having some drive the patient via personal vehicle. However, the possibility exists that the public education campaign may result in an increased utilization of ambulance transportation. This possibility is suggested by information regarding the experiences in Seattle, WA and Richmond, VA where there were paradoxical increases in ambulance transportation after public education campaigns that were actually intended to decrease ambulance utilization. Any change in ambulance utilization as a result of these factors cannot be reliably forecasted, so IPS is not altering its ambulance utilization projections on that basis.
B. Operational Research Results

The hospitals reported that there are approximately 300 pediatrics annually that currently are taken by ambulance to Hamilton General, St. Joseph Hospital and the Henderson hospitals that under the Access to Best Care plan would be transported to the MUMC pediatric ED after the change. Based on the information supplied by HHS, and applying their 2007/2008 experience in the table below, if MUMC become and pediatric only site immediately, 66-70% of patients (approximately 5300 of 7600) now transported to MUMC would need to be transported to an alternative location.

IPS calculates that for ambulance transports of adults that would have gone to MUMC before the change, the closure of MUMC Emergency Department to adult patients will result in a net increase in task time by 84000 minutes or 2.3% to accommodate additional the drive time needed to reach other local hospitals. This considers the additional transport time (approximated at 10 minutes, which constitutes the aggregate travel form McMaster to other hospitals) required for the relocation of approximately 5600 patients as well as an additional 5 minutes for the return of a given until to a location that would appropriately position the unit for a subsequent response in its ‘home’ response area.

Regression analysis was performed as a way to estimate the impact that diversion of 5300 adult patients per year to the remaining three local hospitals will have on hospital off-load times for ambulance patients. Regression analysis showed a very minor increase in hospital offload time associated with the increased load to the alternative hospitals. However, the degree of variability associated with the number of patients received by a given ER was very large, with the model only explaining 5% of the variation in the turnaround time. As a result of our statistical analysis and considering the fact that the average hospital turnaround time is less for two of the three alternative transport hospitals, the decision was made to not include a hospital turnaround component into the task time calculation.

The table below is based on data from the computer aided dispatch system at the CACC showing hospital turnaround time (time unit available at ED – time of unit arrival at ED).

<table>
<thead>
<tr>
<th>Site</th>
<th>TriageLevelDesc</th>
<th>2007/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-17</td>
<td>18</td>
</tr>
<tr>
<td>McMaster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Resusciation</td>
<td>94</td>
<td>2</td>
</tr>
<tr>
<td>2-Emergent</td>
<td>648</td>
<td>14</td>
</tr>
<tr>
<td>3-Urgent</td>
<td>1123</td>
<td>53</td>
</tr>
<tr>
<td>4-Less Urgent</td>
<td>296</td>
<td>10</td>
</tr>
<tr>
<td>5-Non-Urgent</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>McMaster Total</td>
<td>2194</td>
<td>82</td>
</tr>
</tbody>
</table>

Regression analysis was performed as a way to estimate the impact that diversion of 5300 adult patients per year to the remaining three local hospitals will have on hospital off-load times for ambulance patients. Regression analysis showed a very minor increase in hospital offload time associated with the increased load to the alternative hospitals. However, the degree of variability associated with the number of patients received by a given ER was very large, with the model only explaining 5% of the variation in the turnaround time. As a result of our statistical analysis and considering the fact that the average hospital turnaround time is less for two of the three alternative transport hospitals, the decision was made to not include a hospital turnaround component into the task time calculation.

The table below is based on data from the computer aided dispatch system at the CACC showing hospital turnaround time (time unit available at ED – time of unit arrival at ED).

<table>
<thead>
<tr>
<th>Average Hospital Turnaround Time</th>
<th>Calls</th>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMaster's University Medical Centre HHSC</td>
<td>8523</td>
<td>3240</td>
</tr>
<tr>
<td>St. Joseph's Hospital</td>
<td>9962</td>
<td>3335</td>
</tr>
<tr>
<td>The Hamilton General Hosp HHSC</td>
<td>11406</td>
<td>2537</td>
</tr>
<tr>
<td>The Henderson Hospital HHSC</td>
<td>7685</td>
<td>2923</td>
</tr>
<tr>
<td><strong>Average Hospital turnaround all transports</strong></td>
<td><strong>37576</strong></td>
<td><strong>2988</strong></td>
</tr>
</tbody>
</table>
Based on the increase ambulance task time due to changes in drive times and due to changes in off-load times, it is estimated that HEMS will need to deploy an additional 24 ambulance unit hours per day. At an average ambulance unit hour cost of $174 the budgetary impact on HEMS on an annual basis will amount to approximately $1,524,240.

The table below shows information obtained from Hamilton Health Sciences regarding their four hospital emergency department sites:

### Summary Level Trending for Emergency Department Visits at Hamilton Health Sciences

<table>
<thead>
<tr>
<th></th>
<th>Total Visits</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09 Projection*</th>
<th>2009/10 Projection*</th>
<th>% Change 06/07-08/09</th>
<th>% Change 06/07-09/10</th>
<th>% Change 07/08-08/09</th>
<th>% Change 08/09-09/10</th>
<th>% Change 08/09 Proj</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Site</td>
<td>39,168</td>
<td>38,555</td>
<td>39,129</td>
<td>39,129</td>
<td>39,129</td>
<td>-0.1%</td>
<td>General Site</td>
<td>9,061</td>
<td>8,974</td>
<td>8,903</td>
</tr>
<tr>
<td>Henderson Site</td>
<td>30,563</td>
<td>30,560</td>
<td>30,537</td>
<td>30,537</td>
<td>30,537</td>
<td>-0.1%</td>
<td>Henderson Site</td>
<td>7,334</td>
<td>7,374</td>
<td>7,518</td>
</tr>
<tr>
<td>McMaster Site-Adult</td>
<td>24,126</td>
<td>24,147</td>
<td>23,694</td>
<td>23,694</td>
<td>23,694</td>
<td>-1.8%</td>
<td>McMaster Site-Adult</td>
<td>5,589</td>
<td>5,309</td>
<td>5,039</td>
</tr>
<tr>
<td>McMaster Site-Peds</td>
<td>14,469</td>
<td>14,497</td>
<td>14,756</td>
<td>14,756</td>
<td>14,756</td>
<td>2.5%</td>
<td>McMaster Site-Peds</td>
<td>2,241</td>
<td>2,276</td>
<td>2,352</td>
</tr>
</tbody>
</table>

*Peds defined as 0-18 for 06/07 and 07/08 but 0-17 for 2008/2009 forward per MOH MIS guidelines - age 18 averages about 750-800 visits per year at McMaster Source: Meditech

Even if the 2008/09 project of 5039 adult patients is modeled instead of the 5,309 actuals (2007/2008), the unit hours necessary to mitigate the ABS MUMC pediatric only site will not reduce the impact to Hamilton EMS given that the additional coverage that they must deploy has to be in increments of no less than 8 hour shifts.

### C. Literature Review Findings

The literature search found very few articles that had direct relevance to a scenario of assessing the impact of permanent hospital emergency department closure on the community and EMS system in an urban setting. Articles discussing this scenario in a rural setting, such as that facing Dryden in western Ontario (www.dh.dryden.on.ca/news/EDClosure.htm), were excluded because those situations are quite different from the one in Hamilton with closure of an ED in an urban area with several other available EDs in the community. The literature search results were predominantly in context of temporary closures secondary to overcrowding and bypass situations rather than permanent ED closures. These were not particularly relevant to the MUMC scenario in Hamilton.

However, one journal article did yield some directly relevant discussion. The article was in the August 2000 issue of the Journal of Emergency Nursing “Policy Perspectives: Emergency Department Closures: Policy Issues” written by Ruth E. Malone, RN, PhD, and Daniel Dohan, PhD, from San Francisco and Berkeley, California, respectively.

The article cites a bill passed in the 1998 California legislative session (Assembly Bill 2103) that mandates acute care hospitals to conduct an impact assessment, conduct at least one public hearing and notify the State before a hospital is allowed to downgrade or close its ED. An example of such an impact assessment document and the results of public hearing is available regarding the closure of a hospital near Bakersfield, CA (www.co.kern.ca.us/ems/MercyWestsideEDClosureFinal.pdf). The impact assessments are to include the effect on community access to emergency services and the emergency services provided by other entities. Other bills were being considered that would prohibit hospital ED closure if it would not be in the best interest of the general public.
An urban ED closure report from 2003 was found for the North campus of Saint Francis Hospital and Medical Center in Hartford, CT. The document was silent on the impact of the closure on local EMS resources.\(^3\)

Recognizing the limited information available on the impact of permanent ED closures on community health, we did find that the Robert Wood Johnson Foundation has funded a study entitled, “Effects of funding sources on emergency department access and the consequences on patient outcomes.”\(^4\) The investigators “will examine whether decreased emergency department access results in adverse patient outcomes or changes in other health indicators. There is a great deal of literature documenting decreased access to emergency departments. However, there is little empirical evidence linking access to emergency departments and health outcomes. The research will use acute myocardial infarction (AMI) patients to examine health outcomes, since AMI patients are relatively homogeneous and the time sensitivity of treatment should be reflected in differences in outcomes. Specifically, the researchers will analyze: (1) the effect of emergency department closure on mortality rates and other health indicators for AMI patients; and (2) the effect of emergency department diversion on mortality rates and other health indicators for AMI patients. The objective of this project is to provide improved understanding of the impact of ambulance diversion in the health care system.” This study appears to be more directed towards temporary rather than permanent ED closure, but it does highlight the literature gap.

### IV. **Conclusions**

Our operational analyses of the impact that closure of the adult emergency department of MUNC will have on Hamilton EMS leads us to conclude that:

- There will be increases in travel time and hospital off-load time components of the total ambulance task time for the ambulance transports that will be diverted to other hospitals after the MUMC change.
- The increase in ambulance task time translates into a need for an additional 8760 unit hours per year to maintain the current level of emergency response interval performance.
- This increase in unit of 8760 unit hours will cost approximately $1,524,240, based on a ambulance unit hour cost of $174.
- Changes in community behavior are not anticipated to make a significant impact on ambulance utilization.

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\(^3\) Office of Health Care Access Certificate of Need Application: Final Decision (Docket Number: 02-563) on “Emergency Room Closure at North Campus of Saint Francis Hospital and Medical Center”. (www.ct.gov/ohca/lib/ohca/condecisions/02-563dec.pdf)

\(^4\) RFJF Grant ID# 63974; Yu-Chu Shen Ph.D. (Project Director), Naval Postgraduate School Graduate School of Business and Public Policy, 555 Dyer Road, Monterey, CA 93943-5155; (831) 656-2951; yshen@nps.edu; Project start Apr 1, 2008 ending Mar 31, 2010
V. DISCUSSION

There are several factors in these findings that can be exacerbated or mitigated by the actions of HEMS and local hospitals.

Prolonged hospital off-load intervals are already common throughout the City of Hamilton – and in many cities of similar and larger size across North America. Off-load delays can be caused by many factors, but most proximate cause is a lack of ED capacity in relation to demand. The addition of another 5,300 adult patients per year to the remaining 3 local emergency departments is likely to exacerbate the problem. This problem also has several potential solutions.

How the hospitals manage hospital off-loads once the Hamilton Health Sciences plan is implemented will be a key factor driving the impact on EMS. If the local hospitals rely on the same systems, resources and procedures as present to manage hospital off-load, EMS can expects an increase in off-load days as suggested by the regression analysis. However, the following events could mitigate, offset or even result in a net positive impact on the hospital off-loading delay issue:

- MUMC restructuring plan could take 2-3 years to unfold, allowing time for other hospitals and EMS to make incremental adjustments to compensate for the change.
- HHS and St. Joseph’s Health Care may each open a new urgent care centre, which will add ED capacity to the overall community and to allow the ambulance service to transport low acuity patients to the urgent care centres.
- Other local hospitals could achieve the target hospital off-load times noted in the City Council approved resolution of July 11, 2007 which provides that:
  - 90% of the time the patient will be off-loaded and the transfer of care be complete within 15 minutes of the paramedic arriving at the emergency department triage desk, and that this occurs within 30 minutes, 99% of the time
  - the local hospitals continue to work collaboratively with HES to reduce hospital off-load delays by considering the following:
    - continuing to partner with HEMS to track offload times electronically and in real time
    - Reorganization of the emergency departments to improve flow, to include initiation of changes in the way admissions are handled so that patients can be moved out of the hospital faster; In conjunction with HEMS and with the support of provincial funding, continue the program to hire nurses to look after patients from the time the ambulance crew arrives at the hospital until the patient can be seen in the emergency department.

Representatives for the remaining 3 local hospitals have stated they to be able to reduce off-load delays despite the increased number of patients they expect to receive after MUMC is closed to adult patients. Collectively, the local hospitals also expect there will be improved efficiencies and accelerations in patient flow as a result of reorganizing their services among 3 rather than four 4 sites.

There may be other consequences from the MUMC closure, such as:

- Fewer available units in the western areas, with corresponding longer response intervals, because the remaining hospital destinations are located further to the east
Due the longer ambulance task times, this may increase the frequency of “Code Zero” events, where no ambulances are available for immediate response to an emergency because all are already assigned to calls.

Longer ambulance task times may also lead to more frequent missed paramedic meal breaks and involuntary extended shifts for paramedics. This may make it more difficult for HEMS to meet its collective bargaining agreement obligations with staff and the City’s ability to comply with relevant sections of the Employment Standard Act.

MUMC is in the most northwestern location of current EDs. The less densely populated areas of northwestern Hamilton have MUMC as their closest ED. After the change, this may lead to HEMS ambulances posted to northwestern areas having longer total call times to travel to more distant facilities, resulting in a decrease in coverage to the northwestern areas.
Integral Performance Solutions, LLC
a system and process design firm
specialized in healthcare and public safety
CONTRACT # C3-02-06

OPERATIONAL REVIEW OF EMERGENCY MEDICAL SERVICES FOR THE CITY OF HAMILTON
Estimate impact of pending changes at Hamilton Health Sciences on HEMS
Information Sources

- HEMS records from CACC
- Hamilton Health Sciences data on emergency department patient volumes
Operational research analyses conducted in collaboration with

Systems & Industrial Engineering

The University of Arizona
Approach to Operational Modeling and Analysis

• Understanding of system operations;
• Develop model of system based on system’s business rules;
• Make iterative adjustments to enhance its effectiveness at predicting performance accurately
• Use the model to evaluate impact of different decisions
Operational Modeling and Analysis

- Original operational analyses and computer models for HEMS
  - Developed for the 2007 engagement
- Adjusted for the current project
Operational Modeling and Analysis

• Address changes in emergency department destination
  • Changes impacts ambulance task time
  • Changes number of ambulance unit hours needed to achieve a given level of response interval performance

• Secondary analysis
  • estimate potential impact of MUMC change on hospital off-load times
Specific Objectives

- Changes in community behavior impacting HEMS
- Estimate # pediatric transports to MUMC
- Estimate additional # pediatric patients that may be diverted from other hospital EDs to MUMC as a result of its specialization in pediatric emergency care
- Estimate # adults diverted from MUMC to other hospitals
- Estimate changes ambulance task time
  - Include transport and hospital off-load times
- Estimate additional unit hours to compensate for changes in ambulance task time
- Estimate additional units needed for the additional unit hours
- Recommend timing and placement of additional units / unit hours
- Medical literature review for similar scenarios
Findings
Leger report results strongly suggests:

- Residents who would be currently inclined to drive themselves to the ED will probably not change that behavior as the additional drive time from MUMC to the next closest ED is not that much longer. On that basis, IPS does not anticipate a net change in the number of ambulance transports as a result of the change.
Leger report results strongly suggests:

• The public education campaign should clarify which types of problems /symptoms / situations should be seen at the UCC and which should be seen at the ED
• For those that should be seen at ED, the education should offer guidance on which cases may warrant transport by ambulance versus having some drive the patient via personal vehicle.
• However, the possibility exists that the public education campaign may result in an increased utilization of ambulance transportation. This possibility is suggested by information regarding the experiences in Seattle, WA and Richmond, VA where there were paradoxical increases in ambulance transportation after public education campaigns that were actually intended to decrease ambulance utilization. Any change in ambulance utilization as a result of these factors cannot be reliably forecasted, so IPS is not altering its ambulance utilization projections on that basis.
Leger report results strongly suggests:

- Possibility exists that the public education campaign may result in an increased utilization of ambulance transportation
  - IPS: Experiences in Seattle, WA and Richmond, VA where there were paradoxical increases in ambulance transportation after public education campaigns that were actually intended to decrease ambulance utilization
- Any change in ambulance utilization as a result of these factors cannot be reliably forecasted, so IPS is not altering its ambulance utilization projections on that basis.
Operations Research Results: Peds

• Approximately 300 pediatrics taken by ambulance to Hamilton General, St. Joseph Hospital and the Henderson hospitals that under the Access to Best Care plan would be transported to the MUMC pediatric ED after the change
Ops Research Results: Adults

Based on the information supplied by HHS, and applying their 2007/2008 experience in the table below, if MUMC became a pediatric only site immediately, 66-70% of patients (approximately 5300 of 7600) now transported to MUMC would need to be transported to an alternative location.

<table>
<thead>
<tr>
<th>Site</th>
<th>Triage Level/Desc</th>
<th>2007/2008</th>
<th>0-17</th>
<th>10</th>
<th>&gt;10</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMaster</td>
<td>1 - Resuscitation</td>
<td></td>
<td>94</td>
<td>2</td>
<td>154</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>2 - Emergent</td>
<td></td>
<td>648</td>
<td>14</td>
<td>1353</td>
<td>2015</td>
</tr>
<tr>
<td></td>
<td>3 - Urgent</td>
<td></td>
<td>1123</td>
<td>53</td>
<td>3137</td>
<td>4313</td>
</tr>
<tr>
<td></td>
<td>4 - Less Urgent</td>
<td></td>
<td>296</td>
<td>10</td>
<td>614</td>
<td>920</td>
</tr>
<tr>
<td></td>
<td>5 - Non-Urgent</td>
<td></td>
<td>33</td>
<td>3</td>
<td>51</td>
<td>87</td>
</tr>
<tr>
<td>McMaster Total</td>
<td></td>
<td></td>
<td>2194</td>
<td>62</td>
<td>5309</td>
<td>7505</td>
</tr>
</tbody>
</table>
Hospital Off-Load Time Impact

- Regression analysis - estimate impact on hospital off-load time from diverting 5300 adult patients per year to the remaining three hospitals.
- Very minor increase in hospital offload time associated with the increased load to the alternative hospitals.
- Degree of variability associated with the number of patients received by a given ER was very large, with the model only explaining 5% of the variation in the turnaround time.
- Therefore, IPS did not include a hospital turnaround component into task time calculation.
Task Time Impact

- Additional transport time
  - Approx 10 minutes - aggregate travel time to hospital increase
- Additional 5 minutes for the return of a given unit to a location that would appropriately position the unit for a subsequent response in its ‘home’ response area.
- System deployment modeling
  - Unit movements, capacity, variations in demand time, other deployment factors
Task Time Impact

- 8 unit hours per shift smallest added capacity increment
- 8 unit hours x 3 shifts = 24 unit hr / day
- HEMS unit hour = $174
- 24 unit hr. / day x 365 days / yr. x $174/unit hr. = $1,524,240 / yr.
Literature Review

• Studies predominantly in context of temporary closures secondary to overcrowding and bypass situations rather than permanent ED closures
  • These were not particularly relevant to the MUMC scenario in Hamilton
Literature Review

- Calif. Assembly Bill 2103 mandates acute care hospitals to conduct an impact assessment, to include the effect on community access to emergency services and the emergency services provided by other entities.

- Other bills were being considered that would prohibit hospital ED closure if it would not be in the best interest of the general public.

- Conduct at least one public hearing and notify the State before a hospital is allowed to downgrade or close its ED.

- Limited applicability to Canadian healthcare system.
Exacerbation and Mitigation of EMS Impact

- Prolonged hospital off-load intervals are already common throughout the City of Hamilton.
- Most proximate cause is a lack of ED capacity in relation to demand.
- Addition of 5,300 adult patients per year to the remaining 3 local emergency departments is likely to exacerbate the problem.
- This problem also has several potential solutions.
Exacerbation and Mitigation of EMS Impact

• MUMC restructuring plan could take 2-3 years to unfold, allowing time for other hospitals and EMS to make incremental adjustments to compensate for the change.

• HHS and St. Joseph’s Health Care may each open a new urgent care centre, which will add ED capacity to the overall community

• Allow the ambulance service to transport low acuity patients to the urgent care centres
Exacerbation and Mitigation of EMS Impact

• All hospitals achieve the target hospital off-load times noted in the City Council approved resolution of July 11, 2007 which provides that:
  • Off-load <15 min., 90% of the time (and <30 minutes, 99% of the time)
  • Local hospitals continue to work collaboratively with HES to reduce hospital off-load delays by considering the following:
    • Track offload times electronically and in real time
    • Reorganization of the emergency departments to improve flow
    • Use nurses to look after patients from the time the ambulance crew arrives at the hospital until the patient can be seen in the emergency department
Other Potential Impacts

- Fewer available units in the western areas, with corresponding longer response intervals, because the remaining hospital destinations are located further to the east
Other Potential Impacts

• Due the longer ambulance task times, this may increase the frequency of “Code Zero” events, where no ambulances are available for immediate response to an emergency because all are already assigned to calls.
Other Potential Impacts

• Longer ambulance task times may also lead to more frequent missed paramedic meal breaks and involuntary extended shifts for paramedics.
• More difficult for HEMS to meet its collective bargaining agreement obligations with staff and the City’s ability to comply with relevant sections of the Employment Standard Act.
Other Potential Impacts

- MUMC is in the most northwestern location of current EDs
- The less densely populated areas of northwestern Hamilton now have MUMC as their closest ED
- After the change, this may lead to HEMS ambulances posted to northwestern areas having longer total call times to travel to more distant facilities, resulting in a decrease in coverage to the northwestern areas