
Certificate of Authorship

I, Juan Manuel Fraga Sastrías,
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X
21 Sept 2009
Signature
Date

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Abstract


Title: Out-of-hospital cardiac arrest in a Mexican Urban Setting.

There has not been much research around the Emergency Medical Services (EMS) system in Mexico, nevertheless, in comparison to a known framework such as the United States’ (USA) Emergency Medical Services Act, some assumptions can be made: Around half the ambulance personnel in Mexico are volunteers, and most of them have basic emergency medical technician equivalent training, they have an average of 5 years of experience, few personnel has been formally educated at a tertiary educational institution. There is no unique number for EMS activation (such as 911 in USA ), there is not a homogeneous coverage during the different week days and times of the day, consumer participation and public education level is low, although there are standards for patient records the chief complaint is reported in 30.5% of the records. Few Quality improvement efforts are performed.

Outcomes from these kinds of scenario have only been measured in Trauma patients, but the Out-of-hospital cardiac arrest model has never been used as a mean to assess the system. The central aspect of this Thesis is to assess the EMS system at an urban setting using data from out-of-hospital cardiac arrests based on the Utstein style framework. A prospective cohort study was done in the city of Queretaro, Mexico obtaining data from all the ambulance registries of out-of-hospital cardiac arrest victims treated from June 2006 to May 2007. Statistical analysis was performed using means, standard deviations and percentages for categorical variables. Logistic regression was performed to

determine the relation between interventions, times and return of spontaneous circulation (ROSC).

Data from 148 cardiac arrests was obtained. Survival rate (Hospital Discharge) was 0%. 8.6% of the patients had ROSC, no victim was defibrillated previous to ambulance arrival, only 2% were receiving CPR by lay rescuers when the ambulance arrived. Ambulance personnel provided for treatment in less than 30% of the victims. The collapse-assessment interval was $22.5 \pm 19.1$ min and the interval from call to ambulance arrival was $13.6 \pm 10.4$ min. The poor survival rates shown in this study emphasise the need to improve efforts to strengthen the EMS system in Mexico. A series of proposals and recommendations are made in this document.
**Out-of-hospital cardiac arrest in a Mexican Urban Setting.**

**Introduction**

I am a Mexican Physician that used to be a Paramedic.

That phrase might sound common in many places, but I might consider myself lucky; Why Lucky? Less than 5% of the ambulance personnel in Mexico have been trained as Paramedics as the rest are only Emergency Medical Technicians (EMT’s). So I was part of a lucky group of people that from 1993 to 1998 were trained as advanced EMTs (Paramedics) on a three year program at the National University that with time vanished.

I think that the good part of such a program was that like many others I was inspired by the idea of seeing a different emergency medical service in Mexico. For a while we treated patients at the University and around it, just like the Paramedic books said, defibrillating, placing central IV’s, intubating and communicating to the hospital. We had the opportunity to actually see patients surviving from cardiac arrest. We were the second tier for most basic ambulances (from other organisations) around the University but most of us knew that we couldn’t dedicate to that discipline in the long term, so like some others I decided to study medicine.

During those years I had the opportunity to visit Australia, and see a different system. I visited the school of Public Health at the Charles Sturt University and saw the amazing educational program they had using distance education models, simulations and agreements with the state EMS system. I found a unique (not fractioned) system for the whole state of New South Wales and similar systems in the rest of the states I visited. I saw an integrated system with fine communications within the ambulance system and with the hospitals they transported the patients. I saw so many things I wanted to see in my own country. It was by that time that I became really interested in Out-of-hospital cardiac arrest in such a profound way! I read about the “Chain of Survival”, about ideal survival rates, about the idea of having automatic external defibrillators everywhere. I even did a first study at my University to see how many medical interns knew CPR. I found that only 14% of the interns were taught during the medical degree on how to do that technique. That study was supposed to be part of a greater research to evaluate the Chain of Survival in Mexico City which never got the support I was looking for.

More than ten years later I found myself writing a doctoral thesis about Out-of-hospital cardiac arrest and the EMS system in Mexico. How stubborn am I? Well, I don’t know but life has brought me here. When I began this doctorate degree in 2003 I was working in a Kindergarten-grade 12 school, looking after the health and safety of the school, teaching CPR and buying the first defibrillator placed in a school. Now, six years later, I am teaching with simulations at a local University, doing research as part of my daily life and chairing the board of the local Red Cross which provides 80% of the pre-hospital care in the city. What you are about to read, does not only reflect a number of articles and presentations I have made and published in different forums but is also a description of how my life has moved back towards Emergency Medical Services to a position that might influence some change in the future. The data, evidence and information I have gathered during the last 6 years, has moved myself into a place where I actually have the responsibility to do something about it, and not just report the deficiencies of our system.

I am also lucky because around 12% of the population has studied at least one year of higher education in Mexico. I should consider myself lucky because I know how to write and speak in a second language and because I had the opportunity to be exposed to other cultures in Mexico and in

other countries.

The idea of this writing is in part to explain to the reader the difficulties encountered by Mexico in the evolution of the Emergency Medical Services, and in part has helped me remember the frustration I felt back in 1998 when I saw the EMS program I was part of, falling apart. The frustration arose from the lack of political willingness, the lack of public expectations, and the lack of leadership in general. Later on my frustration grew when trying to gather data on out-of-hospital cardiac arrests, to convince EMTs to fill out forms, and to make everyone understand it was important information I was asking for. Who would imagine that 3 years later I would be leading the same organisation I was trying to convince to fill out those forms. In my final report it is not just the frustration I want to write about, but about the hope of changing many of those aspects, through my personal and collective effort.

This text will be divided into 5 chapters:

• **Chapter 1: Introduction.** This chapter has the aim of placing the reader in my own personal context and describing the rest of the document structure.

• **Chapter 2: Mexico and Mexico’s Health care Issues.** This chapter will provide the reader with a general overview of Mexico and its health care system.

• **Chapter 3: Emergency Medical Services Systems in Mexico.** In this chapter the information about the Emergency Medical Services systems will be analysed from a known framework perspective.

• **Chapter 4: Out of Hospital Cardiac Arrest in Mexico.** This chapter will describe the central point of my doctoral studies which is the assessment of the actual EMS in a Mexican Urban community of a little less than 1 million people, using the out-of-hospital cardiac arrest model.

• **Chapter 5: Conclusions and Recommendations.** This chapter will go back to the previous chapters not only to describe how actually the system is working, but to provide with the reader with ideas on how to enhance the actual system.

This doctorate is composed of several activities, chained one to each other in a sequence that help the student understand the discipline he/she wants to merge in, then contrast the information gathered with his/her own context in order to identify a problem worthy of attention, design and conduct a research study and finally report the findings of such a study. In my case it is exactly what happened to be able to produce this document, but spiced with a series of events that maybe are not written but I am sure most research people suffer.

As will be explained in a later chapter, research in the EMS field in Mexico is just emerging and thus the culture for research among EMS stakeholders is very low. While understanding and watching what happened around the world and revising the existing literature I was also trying to develop some research projects in my own context. First with the aim of understanding objectively how the EMS system behaves here for being able to do interventions in the future. It might be precisely that the aspect that consumed most of my effort and that is harder to document. I had to negotiate with authorities, individual EMTs, complete institutions, to make them understand the importance of doing research in the EMS context and establishing research lines to be able to make more objective decisions on ways to lead the EMS development in Mexico.

This is the product of many, many hours of convincing people, calling them so they could fill out forms, convincing them about the importance of reporting this kind of data, explaining them how this data could be used in the decision making process. I hope the reader can perceive that through these lines as it is most probably the most time and effort consuming aspect of this dissertation.

Mexico and Mexico Health Care Issues

The aim of this dissertation is to describe and analyse the state in which Emergency Medical Services (EMS) work every day in Mexico. A great deal of what happens with the EMS system is related to the great need there is in other areas of the health care system. This chapter’s objective is to offer the reader a broad view on how the Mexican health care system is organised in general. An EMS analysis will be treated in a following chapter.

Mexico is a country of contrasts. In about 1,972,550 square km, you can find a huge richness in habitats and climates. It has a coastline of 9,330 km and has many peaks of over 4,000 m above sea level. Of the over 100 million people that populate the country, 20% live in Mexico City, while 25% of the population lives in very small and poor villages. The third richest man of the world lives in Mexico and according to the World Bank 45% of the population lived in moderate poverty in 2005, 18% in extreme poverty.

According to the World Bank (2007) the Gross National Income per capita in Mexico is US$7,310/year. The life expectancy is 75 years of age, and the mortality rate for children under 5 years of age is 27 in every 1000. Tables 1 and 2 show some figures comparing Mexican figures against some selected figures in the surrounding countries.

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<tr>
<th>Population [Thousands]</th>
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<th>Annual birth average [1,000 lb]</th>
<th>Crude birth rate [per 1,000 pop.]</th>
<th>Annual death average [Thousands]</th>
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Table 1.- PAHO 2008. Health related statistics.

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<td>3.1</td>
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<td>Brazil</td>
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<td>...</td>
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<td>15.8</td>
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<td>7,303.73</td>
<td>5.1</td>
<td>25.3</td>
<td>7</td>
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<td>10,180.00</td>
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<td>15.5</td>
<td>3.3</td>
<td>6.4</td>
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<tr>
<td>Cuba</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
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<tr>
<td>Ecuador</td>
<td>2,620</td>
<td>4,110</td>
<td>4,340.59</td>
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<td>17.6</td>
<td>17.7</td>
<td>8.6</td>
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<td>Guatemala</td>
<td>2,400</td>
<td>4,510</td>
<td>4,568.24</td>
<td>3.2</td>
<td>20.5</td>
<td>13.5</td>
<td>2.8</td>
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<td>Mexico</td>
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<td>10,750.71</td>
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<td>12.3</td>
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<td>5,650</td>
<td>6,039.42</td>
<td>6.4</td>
<td>15.3</td>
<td>10.5</td>
<td>10.5</td>
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<tr>
<td>United States of America</td>
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<td>42,000</td>
<td>41,889.57</td>
<td>3.2</td>
<td>8.5</td>
<td>...</td>
<td>5.5</td>
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</table>

Table 2.- PAHO 2008. Socio-economic statistics.

These contrasts can be easily identified when comparing the north of the country with the south. The country can be divided almost in two halves by the Tropic of Cancer. Below it are the states with higher temperatures and humidity, while north of the Tropic of Cancer states highly composed of desert and semi desert are established. Paradoxically the northern states have better economical profiles than southern states. Many reasons may explain this economic difference, however the most important is the close proximity of the northern states to the United States of America which is the main investor in Mexico.

These differences are obviously reflected upon the health situation for each state. As Wilkinson and Marmot (2003) defined there are several issues that affect the health of the society such as:

- Social Gradient: people lower in the economic ladder, live less and have more diseases.
- Stress: people that feel worried, anxious or unable to cope are damaged to their health and this damage might lead to a premature death.
- Early Life: nutrition and education in early childhood is reflected upon the health in the long term.
- Social Exclusion: hardship, resentment, poverty and social exclusion also damages health.
- Work: stress related to work increases health risks, particularly cardiovascular related health risks. It is reported that people that feel a lower control over their job have higher cardiovascular risks.
- Unemployment: higher rates of unemployment are related to more illness and premature death.

- Social support: Friendship, good social networks and strong supportive networks are related to a better state of health.
- Addiction: the abuse of alcohol, tobacco and drugs leads to several health risks, but certain social conditions increase the risk for acquiring these addictions.
- Food: the access to healthy food is controlled by the markets (political issue) and thus they affect the general state of health.
- Transport: less driving and more walking and cycling are related to a better state of health.

Figure 1.- Map obtained from Resorts in Luxury: [http://www.resortsinluxury.com/country-details.asp?ID=5](http://www.resortsinluxury.com/country-details.asp?ID=5)

For example, when comparing the GNI per capita state by state, in 2004 according to the Center for the Study of Public Finances, the state of Nuevo Leon (North of the country) has a GNI per capita of 28,099 pesos (US$2,161.46 dollars-exchange rate 13 pesos/dollar) (adjusted to 1993 prices), while the state of Chiapas’s GNI per capita is of 6,735 pesos (US$518.08 dollars) for the same period with the same adjustment. In terms of GNI, they both occupy the 2nd and 30th places out of 32 states respectively (Centro de Estudios sobre Finanzas Públicas. Cámara de Diputados, 2005).

These differences are reflected on the health profile of the country. While the southern states still suffer greatly from the third world infectious and transmissible diseases, the northern states are mainly affected by chronic, degenerative diseases.

Table 3 shows the mortality rates by grouped causes at the national level, and selected states of Nuevo Leon (North), Chiapas (South) and Queretaro (Central) in 2005 (Dirección de Información en Salud. Secretaría de Salud., 2007).

It is hard to show a broad picture and at the same time a detailed analysis of what happens with the health services in Mexico and specifically in Queretaro. But the aim of this thesis is not to analyse in detail the Mexican health care system but the Emergency Medical Services.

**Mortality Rates**

According to the Health Secretariat (2007), the main cause of death in Mexico is Diabetes Mellitus followed by Ischemic Cardiac Diseases. Table 4 represents the 20 leading death causes in Mexico.

<table>
<thead>
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<th>Nuevo Leon</th>
<th>Queretaro</th>
<th>Chiapas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious, nutritional and reproductive diseases</td>
<td>52.87</td>
<td>63.40</td>
<td>104.92</td>
</tr>
<tr>
<td>Non infectious diseases</td>
<td>490.91</td>
<td>485.49</td>
<td>432.56</td>
</tr>
<tr>
<td>Trauma</td>
<td>43.24</td>
<td>54.74</td>
<td>58.20</td>
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Table 3.- Mortality rates in Queretaro, Nuevo León and Chiapas. (Health Secretariat 2007)

<table>
<thead>
<tr>
<th>Order</th>
<th>IDC 10th rev. Code</th>
<th>Description</th>
<th>Deaths</th>
<th>Rate / %</th>
<th>%</th>
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<tr>
<td>1</td>
<td>A00-Y98</td>
<td>Total</td>
<td>493,957</td>
<td>464.0</td>
<td>100.0</td>
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<td>2</td>
<td>I20-I25</td>
<td>Cardiac Ischemic Diseases</td>
<td>53,188</td>
<td>50.0</td>
<td>10.8</td>
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<tr>
<td>3</td>
<td>K70, K72.1, K73, K74, K76</td>
<td>Cirrhosis and other hepatic chronic illnesses</td>
<td>27,566</td>
<td>25.9</td>
<td>5.6</td>
</tr>
<tr>
<td>4</td>
<td>I80-I89</td>
<td>Stroke</td>
<td>27,370</td>
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<td>5.5</td>
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<td>5</td>
<td>J40-J44, J67</td>
<td>Chronic Obstructive Pulmonary Disease</td>
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<td>6</td>
<td>P00-P06</td>
<td>Some Perinatal Affections</td>
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<td>7</td>
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<td>Road Accidents</td>
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<td>J10-J18, J20-J22</td>
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<td>9</td>
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<td>10</td>
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<td>E40-E46</td>
<td>Caloric-Protein Malnourishment</td>
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<td>13</td>
<td>C33-C34</td>
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<td>1.0</td>
</tr>
<tr>
<td>17</td>
<td>B20-B24</td>
<td>HIV/AIDS</td>
<td>4,650</td>
<td>4.4</td>
<td>0.9</td>
</tr>
<tr>
<td>18</td>
<td>X60-X84, Y87.0</td>
<td>Suicide</td>
<td>4,306</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>19</td>
<td>C53</td>
<td>Cervical-Uterine Cancer</td>
<td>4,270</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>20</td>
<td>A00-A09</td>
<td>Infectious Intestinal Diseases</td>
<td>4,263</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>R00-R99</td>
<td>Not well defined Diseases</td>
<td>9,484</td>
<td>8.9</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>The Rest</td>
<td></td>
<td>159,810</td>
<td>150.1</td>
<td>32.4</td>
</tr>
</tbody>
</table>

/ Rate per 100,000 People

Table 4. - Main Causes of General Mortality, 2005.

Causes 1, 2, 4 and 9 are causes that directly or indirectly are related to sudden cardiac death, making all together 32.5% of all the deaths in Mexico. Also causes 7, 11 and 18 would make part of this important group, but their mortality patterns are different and even in well developed systems the recoverability is very low.

Morbidity Rates

Table 5 shows the diagnoses at discharge of the patients, according to the Health Secretariat (2007).

<table>
<thead>
<tr>
<th>Order</th>
<th>Causes</th>
<th>IDC - 10</th>
<th>Discharged</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>A00-Z99</td>
<td>4 539 477</td>
<td>100.0</td>
</tr>
<tr>
<td>1</td>
<td>Direct Obstetric Causes (Except Abortion)</td>
<td>O10-O75,O81-O92,O96-O87</td>
<td>810 494</td>
<td>17.9</td>
</tr>
<tr>
<td>2</td>
<td>Unique spontaneous Delivery</td>
<td>O80</td>
<td>567 558</td>
<td>12.5</td>
</tr>
<tr>
<td>3</td>
<td>Trauma, intoxications and other external causes.</td>
<td>S00-T98</td>
<td>323 381</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>- Fractures.</td>
<td>S02,S12,S22,S32,S42,S52,S62,S72,S82,S92,T02,T08,T10,T12,T142</td>
<td>149 803</td>
<td>3.3</td>
</tr>
<tr>
<td>4</td>
<td>Some perinatal affections.</td>
<td>P00-P96, A33</td>
<td>187 636</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>- Respiratory Distress of the newborn and other Respiratory problems of the perinatal period</td>
<td>P22-P28</td>
<td>48 574</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>- Slow fetal development, fetal malnourishment and disorders related to short gestation and low birth weight.</td>
<td>P05,P07</td>
<td>29 625</td>
<td>0.7</td>
</tr>
<tr>
<td>5</td>
<td>Abortion</td>
<td>O00-O08</td>
<td>143 083</td>
<td>3.2</td>
</tr>
<tr>
<td>6</td>
<td>Cardiac Diseases</td>
<td>I00-I51 except I46</td>
<td>140 528</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>- Heart Ischemic Diseases</td>
<td>I20-I25</td>
<td>51 870</td>
<td>1.1</td>
</tr>
<tr>
<td>7</td>
<td>Colelitisis and coelecistitis</td>
<td>K80-K81</td>
<td>137 836</td>
<td>3.0</td>
</tr>
<tr>
<td>8</td>
<td>Malign Tumors</td>
<td>C00-C14, C15-C26, C30-C97</td>
<td>136 229</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>- Leukaemia</td>
<td>C91-C95</td>
<td>19 093</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>- Breast Cancer</td>
<td>C50</td>
<td>14 981</td>
<td>0.3</td>
</tr>
<tr>
<td>9</td>
<td>Diabetes mellitus</td>
<td>E10-E14</td>
<td>130 231</td>
<td>2.9</td>
</tr>
<tr>
<td>10</td>
<td>Kidney Failure</td>
<td>N17-N19</td>
<td>124 009</td>
<td>2.7</td>
</tr>
<tr>
<td>11</td>
<td>Abdominal cavity hernia</td>
<td>K40-K46</td>
<td>96 421</td>
<td>2.1</td>
</tr>
<tr>
<td>12</td>
<td>Appendix diseases</td>
<td>K35-K38</td>
<td>94 361</td>
<td>2.1</td>
</tr>
<tr>
<td>13</td>
<td>Intestinal Infectious diseases</td>
<td>A00-A09</td>
<td>84 389</td>
<td>1.9</td>
</tr>
<tr>
<td>14</td>
<td>Influenza and Pneumonia</td>
<td>J10-J18</td>
<td>74 389</td>
<td>1.6</td>
</tr>
<tr>
<td>15</td>
<td>Acute Respiratory Diseases</td>
<td>J00-J06, J20-J22</td>
<td>62 744</td>
<td>1.4</td>
</tr>
<tr>
<td>16</td>
<td>Congenital disorders, malformations and chromosomal anomalies</td>
<td>Q00-Q99</td>
<td>60 642</td>
<td>1.3</td>
</tr>
<tr>
<td>17</td>
<td>Uterine Leiomioma</td>
<td>D25</td>
<td>56 859</td>
<td>1.3</td>
</tr>
<tr>
<td>18</td>
<td>Stroke</td>
<td>I60-I69</td>
<td>40 555</td>
<td>0.9</td>
</tr>
<tr>
<td>19</td>
<td>Liver Diseases</td>
<td>K70-K76</td>
<td>37 510</td>
<td>0.8</td>
</tr>
<tr>
<td>20</td>
<td>Birth control attention</td>
<td>Z30</td>
<td>21 603</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Non classified elsewhere symptoms, or clinical diagnosis.</td>
<td>R00-R99</td>
<td>70 958</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>Other Causes</td>
<td></td>
<td>1 138 421</td>
<td>25.1</td>
</tr>
</tbody>
</table>

Table 5.- Main Causes of Hospital Discharge, 2005

The Mexican Health Care System

Mexico’s health care is provided by many organizations. It can be divided into the public and private health care providers.

At the private level the health care provision is offered by many privately owned hospitals, laboratories, radiology offices, clinics, pharmacies and even ambulance services. All are regulated by the federal and states’ health secretariats. During recent decades the Mexican population has grown substantially and the average age and life expectancy have risen. Nevertheless the public health care system has not grown at the same rate and it has been seen by private investors as an area of

opportunity to develop privately owned health care systems (Figure 2 shows the number of hospital beds per 1000 people). As an example Angeles Hospitals (www.mediks.com.mx) charged 7% of the national consumption in health excluding medications. A few newer groups have begun to develop and open some hospitals around the country such as Star Medica, Christus and CIMA hospitals.

The public health care services are also divided. The two main organisations are the ‘Instituto Mexicano del Seguro Social’ or IMSS and the ‘Instituto de Salud y Servicios Sociales para los Trabajadores del Estado’ or ISSSTE. The first one, IMSS, is financed in part by contributions from workers and employers. It provides health services, retirement funds and other services to the working class. In October 2007 the IMSS had 19,237,138 insured workers and including family members and retired people the number grown to 50,604,762 people (about half the population of the country) (Instituto Mexicano del Seguro Social, 2007). The ISSSTE is financed by the government and contributions from the government employees. In 2003 they covered 10,352,318 (around 10% of the country’s population) out of which 2,367,488 are workers and the rest family members, or retired workers and their families. (Instituto de Salud y Servicios Sociales para los Trabajadores del Estado., 2007)

The workers of the Mexican petroleum company (Petroleos Mexicanos or PEMEX) are covered by a public health and social service owned by PEMEX. Banks and other big companies also have their own health care provision systems.

A high proportion of the population have been treated in the private sector (even when they are covered by IMSS or ISSSTE). Sometimes they are covered by private insurance or more often they personally pay for the treatment they receive. This is mainly caused by the overcrowding and the lack of quality services on the first contact health care facilities of the public sector. Those not protected by either of these systems are serviced by state level managed medical services, supervised and regulated by the Federal Health Secretariat (SS).

This division of the health care and social services system has created an important financial and health related problem derived from a number of reasons:

• The administrative budget of each of these services consumes a significant portion of their revenue.
• Some users are covered by more than one service, creating a non-effective division of these resources. On the other hand, many people are not covered by any service.
• IMSS was created in the 1940’s and ISSSTE in the 1960’s based on assumptions of shorter life expectancy and higher mortality rates. Financially speaking these systems have problems maintaining services for actual workers and retirees and even to pay for the retirement of their own employees.
• Unions have made it difficult to change the way they actually work.

As a result of these administrative issues the health care provision in the country is affected dramatically. To emphasize this, in Queretaro in 2005, the leading cause of death was Cardiac Diseases (62.7/100,000 people compared with 50.0/100,000 at the national level). Access to the ideal treatment for ischemic heart diseases is limited for the open population. While the ideal treatment for the cardiac infarction might include the need to perform primary angioplasty, it is only available in the private sector. Only insured and patients with payment capacity have access to this treatment. In the public sector, patients have access only to thrombolysis, the other treatment alternative, but while the most recommended treatment is rTPA (Recombinant Thromboplasmin Activator) the most common treatment at the public level is estreptokinase. This is evident of unequal access to care. These differences in quality can be measured not only in terms of health related risks, but at an increased cost in long term, complication related, treatments. The next chapter will speak in depth about the Emergency Medical Services in Mexico and in particular in the state of Queretaro where the main study was completed.

Reference List


Emergency Medical Services Systems in Mexico

Now that the reader has a broad view on how the health services are structured in Mexico, it is time to discuss the specific elements of the Mexican Emergency Medical Services (EMS) Systems.

It has not been until recently that research has been published with a focus on EMS systems in Mexico. Although most research has been done on the northern wealthier state of Nuevo León by Arreala-Risa and Mock (1998, 2000, 2002, 2002b, 2004), other research papers, mostly published by Luis Pinet-Peralta (2005, 2005b, 2006) have been published in Mexico City. It is just a partial view of the whole EMS system in this country, but are some of the few research articles that provide data on the actual state of EMS services in Mexico.

In 2004 Fraga published a paper comparing emergency medical technicians (EMTs) in Queretaro with EMTs in Chattanooga, Tenessee (USA) that is consistent with Arreola’s findings on the EMTs profile (Arreola, 2002b). In 2007 Fraga also published a research paper based on an Internet based Survey (appendix 1) in which data was obtained from most of the 32 states in the country. More recently Fraga and Pinet (2008, 2008b) collaborated on the analysis of the data from a volunteer registry in Mexico city that provided more information on the state of the EMS system in Mexico, as well as the profile of the EMS providers in Mexico. Nevertheless, the best available evaluation framework to assess EMS systems comes from survival outcomes from severe conditions such as Trauma or Cardiac arrest. Myers (2008) proposes several other performance measures to assess EMS systems, based on the fact that response times and survival from out-of-hospital cardiac arrest are only related to a minor percentage of the overall treatments provided by the EMS systems (around 2%). Nevertheless, Eisenberg (2009) postulates that interventions done in order to increase survival from cardiac arrest may indirectly affect other health care issues’ prognosis, such in severe trauma. When resources are limited, it might become a good idea to focus on a sever condition such as cardiac arrest first, in order to develop a quality improvement culture and then move to other more common-less sever conditions. This doctoral research focuses mainly on Out-of-hospital cardiac arrest based on this postulate.

When someone mentions the phrase: “Emergency Medical Services” it might trigger some ideas of a system composed in part by ambulance services, nevertheless the idea of what an Emergency Medical Service System is, is a little bit different from community to community.

As defined by Holtermann (2003) the term Emergency Medical Services (EMS) applies to a component of the ambulance services that responds to a medical or surgical emergency on the place where it happens, stabilizes the victim and transports the victim to a medical establishment. VanRooyen, defines some EMS models (1999) which are:

- Hospital Based Models: based and maintained by hospitals. Normally are the easiest ones to maintain and initiate. Medical issues are less complicated based on the availability of medical staff because of its nature.

- Jurisdiction-Directed Models which originate from the municipal or county level, sometimes linked to the fire brigades or other public service. Medical direction is normally hired from

private physicians and it is funded by taxes in all or in part.

• Private ambulance services: which are still strong in some municipalities in the United States but haven’t grown so much at the international level, because these services are provided by others as “free of charge” services.

• Volunteer Systems: using mostly volunteers that are privately trained. In more urban areas they need full time personnel and thus they finally move to hospital based or jurisdictional based models.

• Complex systems which are a mixture of the other mentioned systems.

According to Holtermann (2003) the different models are:

• Third municipal service model: accounting for these essential services as police, fire brigades and finally EMS with a structure similar to VanRooyen’s jurisdictional model.

• Hospital based model just like VanRooyen’s

• Private Service Model

• Incorporated to fire brigades, which is different from the first one just in the sense that is under the same jurisdiction as the fire brigades.

• Incorporated to military services: normally they provide for these services because of a political necessity and most of the time they don’t generate income and when they do, the revenue is normally centralised and doesn’t come back in the form of investment on these systems.

In any case most of these models have all or part of the North American defined at the Emergency Medical Services Act (VanRooyen 1993, Lilja 2004). These areas that deserve analysis are:

• Personnel
• Training
• Communications
• Transportation
• Facilities
• Critical Care Units
• Public Safety Agencies
• Consumer Participation
• Access to the System
• Transfer of Care
• Standardised Patient Records
• Public Information and Education
• Independent Revision and Evaluation
• Disaster Linkage
• Mutual Help Agreements
• Research

I will refer back to the points established by Lilia (2004) and VanRooyen (1993) to illustrate the state in which Emergency Medical Services System functions in Mexico.

Another similar framework to analyse this information comes from Delbridge and colleagues (2009) at the document entitled EMS agenda for the Future which are:

- Integration of Health Services
- EMS Research
- Legislation and Regulation
- System Finance
- Human Resources
- Medical Direction
- Education Systems
- Public Education
- Prevention
- Public Access
- Communication Systems
- Clinical Care
- Information Systems
- Evaluation

Other efforts around the world made to define and enhance EMS systems are worthy of being mentioned in this chapter and also in the recommendations chapter such as the experience of the United Kingdom (Ambulance Service Network 2008, Ball 2005, Bradley 2005, Nicholl, Munro 2000, Robertson-Steel et al 2000), Australia (Audit Office of New South Wales 2007, Blacker et al. 2009, Griggs 2003, O’Meara 2004, 2005), Canada (Canadian Medical Association 2007, Emergency Medical Services Chiefs of Canada 2006), France, Germany (Dick 2003), Malaysia (Hauswald, Yeoh 1997) where even broader aspects for paramedic intervention are being considered such as primary care, preventive medicine a more active physician participation, and different aspects of governance among others.

Because original reference publications were based on Lilia (2004) and VanRooyen (1993) frameworks, I will use it as the framework for this chapter, nevertheless most of the points proposed on the Agenda for the Future (Delbridge, 2009) document will be covered within the text. It is also evidenced by VanRooyen (1993) that the first framework might be related to many EMS systems around the world and might be a base for comparison. The EMS Agenda for the Future is a text focused on North American necessities that might (at least at this moment) differ substantially from the Mexican context.

**Personnel**

The availability of ambulance personnel is one of the key elements of prehospital care systems around the world. Although survival from severe injuries, cardiac arrest and other time dependent emergencies depend on several other factors such as response times, ambulance equipment, and the health system more generally, it is arguable that the capacity of the ambulance personnel to perform effectively is related to better survival rates. This positive association has been documented by authors such as Soo (1999) Stiell and colleagues (1998) and many others in relation to cardiac arrest and Stiell and Collegues (2008), Arreola Risa (2002) and many others in relation to trauma although the relation of advanced life support to better survival is less apparent.

In 2004 Fraga and colleagues applied a survey to Emergency Medical Technicians (EMTs) in the city of Querétaro and EMTs in Chattanooga, Tennessee (USA) (Fraga and Colleagues 2004). Several differences were found, amongst these groups. Part of the data obtained was consistent with what Arreola and Colleagues found in 2002 from a survey in the state of Nuevo León in 2002. A later survey from Fraga and colleagues in 2007 to Emergency Medical Services around the country also found consistent results (Fraga 2007). In 2008 with Pinet-Peralta, the voluntary registry database of EMTs in Mexico City found a small number of advanced providers compared with basic providers, as well as a limited experience (around 6 years). Table 1 compares some general characteristics of these groups.

As can be seen in Table 1, most providers in Mexico are comparatively young (average around 25 years of age), with short experience (around 5 years) and with low levels of training (between 50-100% have basic EMT training or less). Around half of the ambulance service providers receive a salary in this country; this might be one of the reasons why the average length of experience is five years.

Another implication related to whether a salary is paid, is the likelihood that the ambulance personnel will have the opportunity to use their skills more frequently and thus maintain an adequate level of proficiency. Fraga (2004) found that volunteer ambulance crew members had comparatively less experience performing different skills over a year than paid staff. Table 2, shows the difference amongst both groups. The fact that volunteers have less accumulated experience has been related to higher mortality rates on cardiac arrest according to Soo (1999). According to Gold and Eisenberg (2009) the length of experience of the prehospital providers who make decisions doesn't affect the patient’s survival from ventricular fibrillation, nevertheless they found that for every year of experience of the prehospital care provider that performed the procedures (IV lines, airway management, administering medications) the likelihood for survival increased 2%. There is also evidence suggesting that paramedics with more experience who perform this procedure more frequently, have higher success rates with endotracheal intubation (Wang and colleagues 2005, Garza and colleagues. 2003 respectively).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>26</td>
<td>24.2 (6.78)</td>
<td>40.95 (9.28)</td>
<td>30.56 (CI 23-39)</td>
</tr>
<tr>
<td>Years of Experience</td>
<td>5</td>
<td>5.24 (4.69)</td>
<td>16.41 (8.46)</td>
<td>NA</td>
</tr>
<tr>
<td>ET tubes/last year</td>
<td>3</td>
<td>0.74 (1.65)</td>
<td>5.68 (6.34)</td>
<td>NA</td>
</tr>
<tr>
<td>CPR/last year</td>
<td>8</td>
<td>2.33 (2.4)</td>
<td>9.09 (5.26)</td>
<td>NA</td>
</tr>
<tr>
<td>IVs/last year</td>
<td>60</td>
<td>37.67 (80.54)</td>
<td>26.59 (29.16)</td>
<td>NA</td>
</tr>
<tr>
<td>Defibs/last year</td>
<td>NA</td>
<td>0.80 (3.22)</td>
<td>4.23 (4.76)</td>
<td>NA</td>
</tr>
<tr>
<td>Males</td>
<td>NA</td>
<td>56.89%</td>
<td>78.26%</td>
<td>72%</td>
</tr>
<tr>
<td>Receive a Salary</td>
<td>51%</td>
<td>29.33%</td>
<td>90.48%</td>
<td>57%</td>
</tr>
<tr>
<td>First Responder*</td>
<td>22%</td>
<td>-</td>
<td>13%</td>
<td>25%</td>
</tr>
<tr>
<td>Basic EMTs</td>
<td>78%</td>
<td>58.62%</td>
<td>17.39%</td>
<td>27%</td>
</tr>
<tr>
<td>Intermediate EMTs</td>
<td>-</td>
<td>41.38%</td>
<td>8.70%</td>
<td>14%</td>
</tr>
<tr>
<td>Advanced EMT</td>
<td>-</td>
<td>-</td>
<td>56.53%</td>
<td>5%</td>
</tr>
<tr>
<td>Nurse</td>
<td>-</td>
<td>-</td>
<td>--</td>
<td>8%</td>
</tr>
<tr>
<td>Physician</td>
<td>-</td>
<td>-</td>
<td>--</td>
<td>21%</td>
</tr>
</tbody>
</table>

Table 1.- Comparison of Age, Years of Experience, Experiences doing some procedures and level of training of EMTs according to three different studies (Arreola-Risa 2002, Fraga 2004,2007, Pinet 2008). CI=Confidence Interval, NA=Not Analysed.

<table>
<thead>
<tr>
<th>Fraga 2004</th>
<th>Volunteers</th>
<th>Non-volunteers</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>22.44 (4.92)</td>
<td>28.80 (8.77)</td>
<td>p &lt;0.000</td>
</tr>
<tr>
<td>Years of Experience</td>
<td>4.38 (3.86)</td>
<td>7.60 (5.89)</td>
<td>p &lt;0.000</td>
</tr>
<tr>
<td>ET tubes/last year</td>
<td>0.69 (1.75)</td>
<td>0.87 (1.41)</td>
<td>p &lt;0.000</td>
</tr>
<tr>
<td>CPR/last year</td>
<td>1.90 (2.21)</td>
<td>3.47 (2.59)</td>
<td>p &lt;0.000</td>
</tr>
<tr>
<td>IVs/last year</td>
<td>23.18 (28.85)</td>
<td>75.33 (142.11)</td>
<td>p &lt;0.05</td>
</tr>
<tr>
<td>Defibs/last year</td>
<td>0.92 (3.75)</td>
<td>0.47 (0.92)</td>
<td>p &lt;0.000</td>
</tr>
</tbody>
</table>

Table 2.- Differences in experience between volunteer and non-volunteer EMTs in Queretaro, Mexico (Fraga 2004).

Training

While most prehospital care providers in Mexico have the equivalent to basic EMT-training or less (compared to the USA’s National Highway Traffic Safety Administration EMT curriculum), the educational process has to be placed in perspective. At this time in Mexico only five colleges and Universities have approval from the Education Secretariat to provide careers in the prehospital care field under different career programs (all of them at the Associate Professional Level):

- Superior Universitary Technician in Emergencies, Occupational Safety and Rescue (Universidad de Guadalajara [www.udg.mx](http://www.udg.mx))
- Superior Universitary Technician Paramedic (Universidad Tecnológica de Aguascalientes [www.utags.edu.mx](http://www.utags.edu.mx))
- Superior Universitary Technician Paramedic (Universidad Tecnológica de Hermosillo [www.uthermosillo.edu.mx](http://www.uthermosillo.edu.mx))
- Superior Universitary Technician Paramedic-Distance Education (Colegio Latinoamericano de Educación Avanzada [http://www.cleaenlinea.com/portal/](http://www.cleaenlinea.com/portal/))
- Superior Universitary Technician in Medical Emergencies, Emergencias and disasters (Private University in Puebla, México)

Other educational institutions provide for some courses at the level of Graduate Certificate. Nevertheless according to the survey Fraga completed in 2006, it was estimated that there is a total of between 13,000 to 29,000 ambulance crew members in Mexico. Except for physicians and nurses, the rest of the personnel were prepared in one of the courses provided by private volunteer groups. According to these projections 140-300 organisations offer basic EMT courses, 50-105 organisations offer intermediate EMT courses and 27 to 56 organisations offer Advanced or Paramedic EMT courses. More than half the organisations offer continuous education programs (Table 3).

None of these programs have been regulated or supervised by any agency in the Mexico. Just recently the General Health Law was modified to recognise ambulance personnel as professionals (that require for formal training) (Ley General de Salud, 2007). And the only ambulance standard in

Mexico was revised in 2004 (published in 2005) to include EMT competences that should be included in the educational curriculum of these programs.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation Groups</td>
<td>233</td>
<td>492</td>
<td>362</td>
<td></td>
</tr>
<tr>
<td>Ambulances</td>
<td>1,496</td>
<td>3,161</td>
<td>2,329</td>
<td></td>
</tr>
<tr>
<td>Population/Ambulance</td>
<td>31,633</td>
<td>66837</td>
<td>49,235</td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>13,838</td>
<td>29,238</td>
<td>21,538</td>
<td></td>
</tr>
<tr>
<td>Population/Crew Member</td>
<td>3,420</td>
<td>7,227</td>
<td>5,323</td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>2,876</td>
<td>6,077</td>
<td>4,476</td>
<td></td>
</tr>
<tr>
<td>Nurses</td>
<td>1,139</td>
<td>2,407</td>
<td>1,773</td>
<td></td>
</tr>
<tr>
<td>EMT-P</td>
<td>639</td>
<td>1,351</td>
<td>995</td>
<td></td>
</tr>
<tr>
<td>EMT Intermediate</td>
<td>1,931</td>
<td>4,081</td>
<td>3,006</td>
<td></td>
</tr>
<tr>
<td>Basic EMT</td>
<td>3,945</td>
<td>8,335</td>
<td>6,140</td>
<td></td>
</tr>
<tr>
<td>First Responder or less</td>
<td>3,492</td>
<td>7,379</td>
<td>5,436</td>
<td></td>
</tr>
<tr>
<td>Hired Personnel</td>
<td>7,838</td>
<td>16,560</td>
<td>12,199</td>
<td>56.64%</td>
</tr>
<tr>
<td>Volunteer</td>
<td>6,000</td>
<td>12,677</td>
<td>9,339</td>
<td>43.36%</td>
</tr>
<tr>
<td>Trauma Courses</td>
<td>5,334</td>
<td>11,270</td>
<td>8,302</td>
<td></td>
</tr>
<tr>
<td>CPR</td>
<td>5,097</td>
<td>10,770</td>
<td>7,934</td>
<td></td>
</tr>
<tr>
<td>ACLS or equivalent</td>
<td>3,059</td>
<td>6,464</td>
<td>4,761</td>
<td></td>
</tr>
<tr>
<td>PALS or equivalent</td>
<td>576</td>
<td>1,218</td>
<td>897</td>
<td></td>
</tr>
<tr>
<td>AMLS or equivalent</td>
<td>426</td>
<td>899</td>
<td>662</td>
<td></td>
</tr>
<tr>
<td>ATLS or equivalent</td>
<td>3,042</td>
<td>6,427</td>
<td>4,735</td>
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<tr>
<td>ABLS or equivalent</td>
<td>620</td>
<td>1,310</td>
<td>965</td>
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<tr>
<td>Disasters or Equivalent</td>
<td>2,330</td>
<td>4,923</td>
<td>3,627</td>
<td></td>
</tr>
<tr>
<td>Organisation Basic EMT</td>
<td>143</td>
<td>302</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>Organisation Intermediate EMT course</td>
<td>50</td>
<td>105</td>
<td>77</td>
<td></td>
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<tr>
<td>Advanced EMT</td>
<td>27</td>
<td>56</td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.- Projections of the numbers of organisations, personnel, and educational programs in Mexico, based on the survey by Fraga and colleagues (2007).

The projections in table 3 were based on the findings that Fraga and colleagues (2006) reported from surveys returned from 25% and 52% of the registered ambulance organisations in four states from which they were able to get registries.

In other words, there are around 21,000 prehospital care personnel in Mexico who are working in 362 ambulance organisations. While the personnel come from a wide variety of training programs that may be modelled on international programs or other national programs, the programs were not lead, taught or supervised by fully qualified educational staff.

On the other hand, unique efforts led by Arreola-Risa and colleagues (2004), tested Continuous Medical Education Programs such as the PHTLS (Prehospital Trauma Life Support), BTLS (Basic Trauma Life Support) and ACLS (Advanced Cardiac Life Support) courses and their impact over mortality in trauma patients. Table 4, shows the differences encountered in these patients before and after the intervention, and although the differences were not significant in most cases, a trend toward

better survival rates can be seen and according to the author there were also significant differences in intermediate-point measurements such as the number of IV placements, endotracheal intubations, cervical immobilization, and other interventions.

<table>
<thead>
<tr>
<th></th>
<th>Monterrey Before</th>
<th>Monterrey After</th>
<th>p-value</th>
<th>San Pedro Before</th>
<th>San Pedro After</th>
<th>p-value</th>
<th>Santa Catarina Before</th>
<th>Santa Catarina After</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number</td>
<td>361</td>
<td>505</td>
<td></td>
<td>295</td>
<td>215</td>
<td></td>
<td>272</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td>Mortality of all patients</td>
<td>10.3%</td>
<td>7.4%</td>
<td>0.13</td>
<td>3.4%</td>
<td>3.7%</td>
<td>NS</td>
<td>6.4%</td>
<td>9.9%</td>
<td>NS</td>
</tr>
<tr>
<td>Mortality of transported patients</td>
<td>8.2%</td>
<td>4.7%</td>
<td>0.04</td>
<td>1.7%</td>
<td>2.4%</td>
<td>NS</td>
<td>2.7%</td>
<td>2.8%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 4.- Mortality for trauma patients treated by three ambulance services in Monterrey, Mexico metropolitan area. (* Excluding deaths on scene) NS (Non-significant). Arreola-Risa and Colleagues 2004.

Communications

There are few published documents regarding communications in EMS systems. Nevertheless from the anecdotic viewpoint it is a general knowledge that communication between EMS services and hospitals is very limited and in most cities in Mexico non-existent. Another major problem with communication among Emergency Medical Services is the number of different organisations providing prehospital care. For example, the city of Querétaro (population of approximately 800,000 people) has 13 different ambulance organisations, each with different structure: 2 government agencies (state level and local level Civil Protection), 7 non for profit organisations (1 of them Mexican Red Cross, Queretaro delegation) and 4 private (for profit) organisations.(Fraga 2007b) this “fragmentation” is not a unique problem in Mexico, as stated by Eisenberg (2009) it is also a problem reported in several cities in the United States. In other countries such as the United Kingdom or Australia, they have also many different ambulance services but they provide for prehospital care a single service per region fashion and thus eliminating the inconvenient of a fragmented service with poor coordination.

The United States EMS Agenda for the Future, document, makes the following recommendations in regard to communications systems:

- Assess the effectiveness of various personnel and resource attributes for EMS dispatching.
- Receive all calls for EMS using personnel with the requisite combination of education, experience and resources to optimally query the caller, make determination of the most appropriate resources to be mobilized, and implement an effective course of action.
- Promulgate and update stands for EMS dispatching.
- Develop cooperative ventures between communications centers and health providers to integrate communications processes and enable rapid patient-related information exchange.
- Determine the benefits of real-time patient date transfer.
- Appropriate federal, state, and regional funds to further develop and update geographically integrated and functionally based EMS communications networks.
- Facilitate exploration of potential uses of advancing communications technology by EMS.
- Collaborate with private interests to effect shared purchasing of communication technology.

There is no documented experience in relation to any of these points in Mexico.

![Graph showing proportions of emergency numbers used by different EMS organisations in Mexico.]

Figure 1.- Proportions in which each emergency number was reported as their contact number by the different EMS organisations in Mexico. (Fraga 2007, 2007c).

On the other hand, there is the question about how the population makes contact with the Emergency Medical Services. According to one survey (Fraga and colleagues, 2007, 2007c) it was found that the number reported by the different EMS organisations as the one used to contact them was very heterogeneous. Figure 1 shows the proportions in which each number was used (066 is supposed to be the national emergency number, equivalent to 911 in USA and Canada, 999 in Britain or 000 in Australia).

As can be seen, less than 40% of the organisations are accessible via the official number (066). No major public campaigns regarding emergency phone numbers have taken place in Mexico, and authorities are concerned about the misuse of these numbers (Rivera 2008, Zambrano 2008).

Transportations, Facilities and Finances

When speaking about the resources and facilities delegated to prehospital care in Mexico, many interesting points can be raised. According to Fraga and colleagues’ (2006) internet based survey, 21% of the prehospital providers were public (state financed), 31% were NGO (financed by donations, or volunteer based), 33% were private, 9% were a combination of private-NGO and 6% didn’t provide any response.

This survey asked respondents if the institution was part of a bigger organisation (such as Red Cross Branches in Mexico) or if it was an individual or stand-alone organisation with no branches. Sixty three percent of the organisations, identified as individual organisations with no branches. This number reflects that, at least from the administrative perspective, most ambulance services are independent from each other and therefore running the risk of having variations in coordination and standardisation of care. There are no defined standards of EMS care in Mexico, which therefore increases the risks of

providing non-standardized, non-evidence-based care.

As a large number of ambulance services are crewed and financed by volunteers, the times and days in which they provide services varies. Fraga and colleagues’ (2006) survey asked (appendix 1) for the times and days of the week in which services were provided. They found that the number of ambulance services that provide care with at least one ambulance available varies by the day of the week and the time of day. That means that although ambulance inventories in the cities might be considered ‘enough’, the real number of ambulances available to provide care at any given time might be different from total numbers reported. Table 5 shows the percentage of ambulance organisations that provide care with care from 117 that answered this question.

<table>
<thead>
<tr>
<th>Number of Organisations: 122. Organisations that answered 117.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>Morning</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Afternoon</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Night</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Avg</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 5– Ambulances providing with care, in relation to time and day of the week. In Bold are those times and days that are above or equal the complete average.

Some public administrated health care systems such as de Instituto Mexicano del Seguro Social (IMSS) and the Instituto de Salud y Seguridad Social de los Trabajadores del Estado (ISSSTE) have their own ambulances (2500 and 800 nationwide respectively) but most of these ambulances are used only to transport patients from one hospital to another or to transport them as a programmed event. The Mexican standard that is used to regulate ambulances (NOM-020-SSA2-1994) was revised recently to become (NOM-237-SSA-2004) and left out these types of ambulances. No Mexican standard or law applies to these service and vehicle standards, even though they may be a resource that offers the potential to improve service delivery across the country. These organisations already have a strong financial base and have ambulance resources located across the country.

Critical Care Units (Ambulance)

There is no standard defining which units should be used in the different settings around the country. Nevertheless legally speaking the classification for ambulances in Mexico include four categories (NOM-237-SSA-2004):

- Transportation ambulances: focused on non-urgent transportation from one facility to another. According to the Mexican standard (NOM-237-SSA-2004) but as mentioned earlier, no equipment or personnel training is defined for these vehicles and most the vehicles at IMSS and ISSSTE fall into this classification.
- Basic Emergency Care Units: should include equipment and personnel (Basic EMTs) for basic life support.
- Advanced Emergency Care Units: which should include equipment and personnel (Intermediate and Advanced EMTs) capable of providing advanced life support emergency measures.
- Critical Care Units: designed for the transportation of patients with severe conditions from one facility to another. According to the Mexican standard (NOM-237-SSA-2004), these units

should have advanced equipment including transport ventilators, 12 lead ECG, etc and be staffed by medical doctors specialised in prehospital care.

Nevertheless there is no objective definition of when each type of ambulance should be used or any recommended procedures to activate their deployment.

Public Safety Agencies

Public safety and particularly public security has become a major topic of discussion and action in Mexico. Recently the General Law (Federal) for Public Security was reformed and published (Cruz 2009). This law integrates the police corps at all levels (Federal, State and Municipal), they will share information, certification strategies, training and other development alternatives. all coordinated at the national level by a National Security Council. Nevertheless, this and other state and municipal laws do not observe the need to coordinate efforts with other public safety agencies such as fire brigades, EMS services, etc. The only laws that relate these services are the Federal and state level Civil Protection laws that mandate coordination through the Civil Protection Units at the Municipal, State level and the National Coordination of Civil Protection for all the Public Safety related agencies including volunteer groups, although it is only mandated on disaster situations. More information about these laws can be obtained through the Protección Civil (Civil Protection) Webpage: www.proteccioncivil.gob.mx

Consumer Participation

Consumer participation plays an important role in EMS systems. As stated by Lilia (2004) two important aspects are fundamental for the EMS system. One is the implementation of a universal telephone number, that as seen in Figure 1 although the number 066 should be the Universal access number in Mexico, it is actually used by less than 40% of the ambulance services in the country. The second one is first aid training for the laypersons, and although it is observed in some laws and standards in Mexico, as will be discussed later in this work the percentage of patients that actually receive CPR after an out-of-hospital cardiac arrest is really low (Fraga 2009). Because around 31% of the organisations, including the Mexican Red Cross are Non-for-profit organisations (NGOs) (Fraga 2007) their governance might include people from the public that can provide for an input on their day to day activities, nevertheless this public influence only affects the governance of the ambulance services, not the overall EMS system governance which in the cases in which it is leaded by someone, it is mainly by a public server or a public agency (eg. Health secretariat or civil protection directorate).

Access to the System

Universal access is a desirable aspect of well organized EMS systems. In order for them to be accessible for most of the community, good response times, good quality of care, and other performance aspects should be equally available to all community members (Lilia 2004). As mentioned earlier there are some considerations that should be taken into account when evaluating EMS systems in Mexico.

- Not all the ambulance services work permanently during the week and different times of the day (80-95%) Table 5.
- This is mainly caused by the high prevalence of volunteer ambulance services providing this care. Just around 50% of the personnel receive a salary (tables 1 and 3) which reflects the way

Ambulance services are financed in Mexico. According to the results in the survey (appendix 1) made by Fraga and colleagues (2007) 21% of the ambulance services are financed by state organizations, 31% are volunteer based, 33% are private ambulance services that finance themselves through private insurance or payment by the users, 9% are a combination of volunteer based and privately administered systems and 6% didn’t answer this part of the survey. These figures are independent from the proportional influence (number of services attended) and the size of each organization (number of ambulances, personnel, etc).

- Response times are reported in only a few documents, however those reported indicate that response times are high in Mexico. Arreola-Risa (2000) reports response times of $15.5 \pm 5.1$ minutes before intervention and then $9.5 \pm 2.7$ minutes after the intervention in Monterrey, Mexico. In Mexico City the response times estimated are estimated to be 40 minutes (Secretaría de Salud del Distrito Federal, 2008). As will be detailed in the main chapter of this thesis the response times in Queretaro are $13.93\text{mins}$ in average (mean) (St.dev $10.72\text{mins}$) (Fraga 2009). Although very variable from one city to another, all these response times are very high especially for time dependent situations such as cardiac arrest.

As an example of what happens in other countries, in Australia, some performance indicators are used to measure this equal opportunity among the different Australian Communities (O’Meara, 2005), these are:

- Survival rate from out-of-hospital cardiac arrest
- Ambulance incidents responses and patients per 100,000 people.
- Proportion of emergency cases which receive a paramedic level of response.
- 50th percentile and 90th percentile response times.
- Level of patient satisfaction.
- Unit cost.
- Expenditure per urgent and non-urgent response.
- Expenditure per person.

Some goals established were:
1. 95% of the activation times should lie within 3 minutes
2. In metropolitan services 50% of the response times should lie within 7 minutes and 95% within 14 minutes
3. In non-metropolitan services 50% of the response times should lie within 8 minutes and 95% within 20 minutes

Transfer of Care

According to Lilia (2004) transfer of patients from one medical facility to another should be assured in a safe manner based on agreed standards. According to the recently published standard (NOM-237-SSA-2004) the figure of a Medical Emergencies Regulation Center is created (CRUM by its initials in Spanish). This center is administered by the Health Secretariat at each state in the country. The
agreements mentioned by Lilia are in part favoured by the CRUM.

The only CRUM that has published any results countrywide is the one in Mexico City, and the agreements they have signed up are published in their webpage (Secretaría de Salud del Distrito Federal, 2008b). With these agreements they have overcome the boundaries between the different health care subsystems that prevail in Mexico (refer to the previous chapter) and have signed up referral agreements between the Health Secretariat, the Mexican Institute of Social Security (IMSS) and the Institute for Social Security and Health for the State Workers (ISSSTE) in order to offer treatment to patients in the most appropriate institution under acute situations. The CRUM is in charge or regulating these referrals, nevertheless it is the only experience reported country wide and it only benefits a population of 8 million people (Federal District habitants, within the limits of what is known as Mexico City), out of the 100 million that populate Mexico.

**Standardised Patient Records**

According to the NOM-237-SSA-2004, all the prehospital medical records should include the following data (NOM-237-SSA-2004):

- Date of the Service
- Type of Service (emergency, transfer, intensive care)
- Location (home, public site, etc)
- Time of ambulance departure
- Time of care ending: either because care was finished or patient received at a hospital facility
- Identification of Personnel
- Patient Data: name, age, gender
- Pathologic Antecedents
- Actual complaint:
  - Trauma vs. Non-trauma patient
  - Mechanism of injury
  - Sudden, Chronic or complication of chronic disease
- Physical Examination
  - Vital Signs
  - Skin state and coloration
  - Pupils
- Description of injuries or damages
  - Location
  - Type
- Treatment provided
  - Airway
  - Ventilation
  - Circulation
  - Intravenous fluids
  - Drugs
  - Immobilization
  - Observation
- Patient Transfer: Hospital, Home, Refuses treatment, other

Although, some of these might be useful, some of them might be needed in case research wants to be

done (eg. Utstein Style Records, in Jacobs and colleagues. 2004). From another perspective, Pinet (2005b) analysed the ambulance records from one ambulance service in Mexico city finding that in 30.5% of the reports the Chief Complaint was not reported and the author was not able to estimate response times (interval time from call to ambulance arrival) with the information available, instead he reported only total response time (interval from ambulance dispatch to ambulance available again). Although a standard record is obligated by law, not filling ambulance records in an appropriate manner is a common finding.

Public Information and Education

According to Lilia (2004) a public information program should consider that the public:

1. understands how the community stands to benefit from an excellent EMS system
2. is prepared to render first aid care
3. knows how to quickly access the EMS system, and
4. understands patients may not be delivered to the hospital of their choice under life-threatening conditions.

Although no study is directly focused on Public Information in Mexico, some aspects can be inferred from what is published.

The fact that in up to 90% of the occasions where there is an abuse of the emergency number in different municipalities as reported by some newspapers and other media (Rivera 2008, Zambrano 2008), the low public CPR rates (Fraga 2009, and next chapter), long intervals from collapse to ambulance activation (Fraga 2009, and next chapter) reflect in great manner the need the Mexican population has to understand how an ideal EMS system should work.

Independent Revision and Evaluation

Lilia (2004) recommends that EMS system agencies implement quality control measures such as review of response times, review of patient care records, survival from cardiac arrest and severe trauma. In the survey (appendix 1) published by Fraga and colleagues (2007) around 70% of the organisations reported following up response times, less than 40% assessed survival to arrival at the hospital and around 30% followed up on patients, just above 10% of the organisations reported having external reviews (audits) of their own processes.

Disaster Linkage

As an integral part of the disaster preparedness and planning, the EMS should be involved with other public safety agencies, communicating with them about disaster situations and hazards and have information from hospitals about their capacity to receive certain kind of patients under disaster conditions (Lilia 2004). Apart from the existing legislation which forces ambulance services to be registered with the Civil Protection agencies at the local and state level (Secretaria de Gobernacion, 2009) the only antecedent of actual agreements with hospitals and reports at the operational level is the Medical Emergencies Regulation Centre (CRUM) at Mexico City (Secretaría de Salud del Distrito Federal 2008). They operate a continuous reporting system which assesses the capabilities of the different hospitals with which they have signed agreements every eight hours in order to determine the state of readiness at the different times of the day.

It is obligated by law that private institutions, ambulance services, hospitals, factories and, generally

Speaking, all the establishments along the country have their own disaster plans in place. It is also recommended that every organisation perform at least one disaster response drill per year, mostly focused on evacuation procedures. The recent events with the Influenza A, H1N1 epidemic that started in Mexico, made it evident that although some plans were in place, the prehospital care services were not considered among the response efforts (Fraga, 2009b).

Mutual Help Agreements

As has been described earlier in this chapter, a big difference between Mexican EMS system and the EMS systems in many other countries is the fragmentation and heterogeneity of the system itself. According to Fraga and colleagues (2007) 122 ambulance services responded to their survey (appendix 1) and these respondents represent between 25% and 50% of the total number of ambulance services in the country. That means that there are between 244 and 488 different ambulance services in the country. The responses were received from 26 out of the 31 states of Mexico and the Federal District. The influence of each organisation for the prehospital care service is variable. In few cases there are written agreements between organisations and/or with the government or hospitals (Briones 2008, Miranda 2007).

Research

This is not one of the original 15 elements, but Lilia (2004) points out that it is needed to determine which therapeutic interventions are beneficial and which are not. Lilia insists in that investment in research is the key to improved EMS practice. In Mexico, biomedical research is a well established field, but the research around EMS systems is quite new and only a small number of authors and research projects are known in Mexico. An exhaustive internet and printed media search was undertaken to find any relevant research reports in this area. Table 6 shows some examples of the results of this research using Pubmed (NCBI, 2009) to identify abstracts and papers that were related to Mexico:

<table>
<thead>
<tr>
<th>Keywords</th>
<th>No. of Papers</th>
<th>Topics</th>
<th>First Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS Mexico</td>
<td>6</td>
<td>Trauma, EMS systems, disasters</td>
<td>Arreola-Risa, Pinet-Peralta, Roudsari, Spivak, Mock</td>
</tr>
<tr>
<td>Paramedics Mexico</td>
<td>11</td>
<td>EMS systems, EMT training and certification, cost-benefit measures,</td>
<td>Pinet-Peralta, Arreola-Risa, Fraga-S, Rivera-Damm,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural medical care, community health technicians, Folk practitioners,</td>
<td>Güel-Jimenez, Romero-Cabello, Hamburger,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rodriguez-Dominguez, Garza.</td>
</tr>
</tbody>
</table>

Table 6.- Example of keywords and research papers related to Mexico at PubMed (www.pubmed.gov).

An effort should be made to establish research priorities in Mexico as well as it has happened in other


According to the EMS Research Agenda for the future (Sayre 2001) some of the following strategies might strengthen EMS research and thus EMS systems in general:

- Develop researchers: through fellowship programs for example.
- Facilitate collaboration: as an example they propose the creation of centres of excellence for EMS research.
- Establishing a reliable funding stream: such as sponsoring research through federal agencies.
- Establishment of alternative funding sources: such a states, corporations and charitable foundations.
- Recognition of the need for EMS research: by joining the efforts of EMS professionals, delivery systems, academic centres and public policy makers towards the support and use of EMS research.
- View research as necessary for the improvement of patient care: the ideal situation would be to have EMS providers to hold themselves to higher standards of requiring evidence before implementing new procedures, devices or drugs.
- Create reliable information systems: standardized data collection systems should be created at all governmental levels. This data should not include patients’ personal data but standardised elements should be included in all EMS systems data collection.
- Enhance ethical approaches to research: there are serious impediments in EMS research, mainly related to the requirements for exception from informed consent that has resulted in serious impediments to perform EMS research.

Conclusion

Although with some history, the Mexican EMS is far from being at an ideal state. The major challenges are:

- Public awareness and education
- Standardisation and homogenisation of EMS systems
- Coordination, Efficient Communication and Universal Access

All this would be benefited by a change in the financial model used in Mexico which relies in an important manner on volunteer based systems.

The major strength of the Mexican prehospital care is the big number of providers that are already dedicated to this activity and that can become a strong influence towards a change of paradigm if they are motivated and educated about the economical and health related potential of a quality EMS system in Mexico.

Most aspects addressed based on the framework used (Lilja, 2004) need to be addressed in Mexico. In the last chapter I will be covering some recommendations based on the observations made in these and other chapters.

Appendix 1
Survey realized by Fraga and Colleagues (Fraga 2007)

Name of the organisation: ________________________________
State in which it is located: ______________________________

What kind of organisation is it?

- Is it an organisation with a single branch
- The person that is responding the survey is part of a branch of a bigger organisation

How is the organisation financed?

- It is or is part of a public agency
- It is an NGO that is mainly funded by donations
- It is a private organisation that is financed by fees, subscriptions, and/or other payments
- It is a mixture of the previous services (Private-Public-NGO)

How much personnel does it have?__________

From the total amount of personnel:

- All receive a salary
- Less than 10% are volunteers, the rest perceives a salary
- 11-30% are volunteers, the rest have a salary
- 31-50% are volunteers, the rest have a salary
- 51-80% are volunteers, the rest have a salary
- More that 80% are volunteers, some have a salary
- All are volunteer

From the total number of people at the operative level ¿How many correspond to each training level?

- Lower than basic EMT_____
- Basic EMT _____
- Intermediate EMT _____
- Advanced EMT/Paramedic _____
- Nurse_____
- Physician_____

Does the personnel has an academic certification that corresponds to their training level external to the same organisation? Yes/No

Approximately How many members of the personnel has any of the following courses/certifications?

- PHTLS or ITLS: ______
- BLS or CPR: ______
- ACLS o equivalent: ______
- PALS o equivalent: ______
- AMLS o equivalent: ______
- ATLS o equivalent: ______
- ABLS o equivalent: ______
- ADLS o equivalent: ______

Select all that apply regarding the training you provide:

- We don’t offer training
- We train our basic life support personnel

- We train our intermediate life Support personnel
- We train our advanced life support personnel
- We have a continuous education program

Which of the following performance indicators are used in your organisation at least once per month to measure quality:
- Response times
- Survival of patients at hospital arrival
- Satisfaction surveys
- Follow up on patients status
- Academic assessment of personnel
- Administrative assessment of personnel
- External audits
- Others: ________________

What kind of medical direction do you have?
- We don’t have medical direction
- The medical director only represents the organisation with medical authorities
- We have indirect medical direction (based on protocols and guidelines)
- We have direct medical direction (by radio or telephone) but it is not permanent
- We have direct medical direction (by radio or telephone) permanently

In which times and days do you provide with your service normally?

<table>
<thead>
<tr>
<th></th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afternoon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How many ambulances do you have for emergency care?_______

Number of monthly services:
- 0 to 20
- 21 to 50
- 51 to 100
- 101 to 200
- more than 200

Which numbers can the public can use to activate your service?
- 060
- 065
- 066
- 080
- Own Telephone number
- 800 number (toll free)
- Other: ____________

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Out of Hospital Cardiac Arrest in one Mexican City

It is yet to be well established how responses to Out-of-Hospital cardiac arrest affect overall the state of public health around the world, and Mexico is no exception. There is no study published in Mexico about how out-of-hospital cardiac arrest affects the state of health in this country. Nevertheless estimates can be made from the data published in other countries reflecting the importance of this problem (Rea et al 2004, Asensio 2005, Cobb 1999, Spaite 2001, Cummins et al 1991).

Rea et al (2004) have calculated the potential incidence of out-of-hospital cardiac arrest in the United States based on the National Registry of Out-of-Hospital cardiac arrest. They have established an average incidence of 1.89 cases per 1,000 habitants per year. These figures varied up to 30 fold across clinical subgroups: 0.82/1,000 in patients with no previous disease, 5.98/1,000 in patients with any known cardiac condition, 13.69/1,000 for patients with history of myocardial infarction and 21.87/1,000 in patients with cardiac failure. In another study based on EMS treated cardiac arrest Rea reported an incidence of 54.99/100,000 person-years of incidence and 21.32/100,000 person-years of cases with ventricular fibrillation, a potentially reversible cause of arrest (2004).

According to these figures a similar incidence could be expected in Mexico, and particularly in Queretaro that has conditions similar to cities where these studies were conducted such as in Seattle (population around 1 million people, good living conditions, similar epidemiological profile where chronic diseases and accidents occupy the main death causes). If this was the case, with a population of 100 million people the annual incidence would be 189,000 victims per year. In the city of Queretaro (population 800,000) these figures would reflect an incidence of 1,512 cases per year of which 439 would be EMS treated and 170 would be cases with ventricular fibrillation. According to Asensio et al (2004), in Mexico there could be 53,000 sudden deaths per year, nevertheless it is a conservative number compared to the previous calculation.

Survival, defined by being discharged alive from the hospital, from this event is determined by various factors, the most important are: early access by bystanders which is the early detection of the event by a bystander; early CPR (cardiopulmonary resuscitation) by the bystander; early defibrillation (preferably before 8 minutes) Stiell (2004). Advanced life support has also been defined as a survival predictor, but with less influence. Figure 1 shows the odds ratio for these factors according to Stiell et al. Although in the original Chain of Survival studies Cummins et al (1991), advanced life support systems had a stronger support Stiell (2004). There is less evidence of its usefulness in settings without Public Access Defibrillation (PAD) Programs and well-developed community education programs.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt;75 yr</td>
<td>1.6 (1.2–2.3)</td>
</tr>
<tr>
<td>First link: early access by bystander</td>
<td>4.4 (3.1–6.4)</td>
</tr>
<tr>
<td>Second link: early CPR by bystander</td>
<td>3.7 (2.5–5.4)</td>
</tr>
<tr>
<td>Third link: defibrillation in ≤8 min</td>
<td>3.4 (1.4–8.4)</td>
</tr>
<tr>
<td>Fourth link: advanced life support</td>
<td>1.1 (0.8–1.5)</td>
</tr>
</tbody>
</table>

Fig. 1. - Odds Ratio for Survival to Hospital Discharge Associate with Selected Factors (Stiell et al. 2004)

Cobb et al (1999) demonstrated similar influence over out-of-hospital cardiac arrest from ventricular fibrillation outcomes as shown on figure 2. The most important factors influencing survival are witnessed collapse, bystander CPR, public location and short intervention periods. Again, community related factors are the ones that show higher influence over survival rates.

From another perspective, cardiac arrest is a fine model to evaluate the effectiveness of emergency medical services (EMS) systems in terms of the final outcome which is survival at hospital discharge (Spaite et al 2001) particularly in time dependent situations such as trauma or cardiac arrest. According to Spaite et al (2001) the episode of care model is recommended to be used in critical, time dependent outcomes research, such as cardiac arrest. Textually they say: “Non-traumatic cardiac arrest is the prototypical condition for use of this model” in the classical EMSOP II article (Spaite et al 2001).

Although EMS systems have been evaluated in Mexico in terms of trauma related outcomes (Arreola-Risa 2000, 2004) no study has been made in Mexico using cardiac arrest as a model to assess EMS systems which as mentioned earlier is a prototypical model for the assessment of EMS systems.
Arreola-Risa et al (2000, 2004) have been analysing trauma related outcomes in the city of Monterrey (north of Mexico) and made some interventions such as Pre-hospital Trauma Life Support (PHTLS) training, increasing the number of ambulance bases, ambulance crew certification and its impact over trauma related mortality, finding that some low cost interventions have diminished it. Nevertheless mortality from out-of-hospital cardiac arrest and interventions to diminish it has not been yet implemented in the Mexican context.

The Utstein style is a framework recommended for cardiac arrest research by the International Liaison Committee on Resuscitation, initiated in 1991 and since revised on several occasions, the last being in 2002 (Jacobs et al. 2004). This framework was created after the need to uniformly report research related to out-of-hospital cardiac arrest that permitted researchers to have a simple, practical template for uniform data collection, either for registries (focused more on quality improvement) or research. This template has the aim of leading to better, more accurate data acquisition and reporting from out-of-hospital cardiac arrests that can help researchers, providers and policy makers to compare results or analyse them from a broader perspective. The 2002 version (Jacobs et al 2004) simplifies it even more, based on recommendations by other authors and also based on the research that yielded in the 2000 cardiac arrest management guidelines.

Some operational definitions from this framework are included in this thesis (Jacobs et al 2004) and are available as an annex to this chapter.

In the same document (Jacobs et al. 2004) standards to report dates and times are also established. Two important intervals that are very important to consider are the collapse-to-first CPR attempt interval and collapse-to-first defibrillator shock interval. Nevertheless clock inaccuracy and synchronisation errors are common existing problems. The task-force that revised the Utstein style defined core time events to be recorded, making an emphasis on the fact that an effort should be made to register them accurately.

The Core times to be recorded are (Jacobs et al. 2004):

- Time of Witnessed/Monitored Arrest
- Time When Call Received
- Time of First Rhythm Analysis/Assessment of Need for CPR
- Time of First CPR Attempts
- Time of First Defibrillation Attempt If Shockable Rhythm

First “Out-of-hospital cardiac arrest” prospective study in Mexico. (Fraga et al 2009)

As a first attempt to analyse the state of EMS systems in the city of Queretaro, Mexico Fraga et al (2009) analysed ambulance records from the Mexican Red Cross branch in the city of Queretaro, which treats around 90% of the pre-hospital care services in the urban area of Queretaro which has a population of around 800,000 people.

The study was designed as a prospective cohort study. The data was obtained from the ambulance registries of the patients treated between June 2006 and May 2007. All patients with cardiac arrest previous to the ambulance arrival or during transport to the hospital were included. The records were reviewed by two independent observers who captured the data in Utstein style formats (Jacobs et al. 2004) and then they were analysed by a third researcher. When possible, treating EMT´s were

interviewed to clarify or extend data. The research proposal was approved by the Charles Sturt University Ethics Committee (approval number: 2006/081 and appendix 2) and the Mexican Academy of Pre-hospital Medicine Ethics committee.

The information obtained was:

- Gender
- Age or date of birth
- Cause of Arrest
- Time of collapse
- Time in which call was received
- Time of arrival
- Time in which patient status was assessed
- Procedures performed by ambulance crew members:
  - Thoracic compressions
  - Assisted ventilation
  - Airway control
  - Defibrillation
  - Pharmacological Interventions
  - Procedures by lay-rescuers (bystanders)
- CPR
- Defibrillation
- Level of training of the providers that treated the arrest

Outcomes measured were:

- Return of Spontaneous Circulation
- Arrival to the Hospital with Circulation
- Survival to Discharge
- Survival at one year (a call was supposed to be made in all patients that were discharged alive, but as will be seen in results, the call was never needed)

Other data recommended at the Utstein style framework such as Cerebral Performance Category and location of the arrest, was not obtained, because it was not contained in the ambulance registries. Appendix 3 shows the data collection form.

A Chi square test was applied to all non-parametric data to assess significance, as well as calculating Odds Ratio. Logistic Regression was used in order to determine the effects between time intervals, procedures and ROSC and arrival to the hospital with circulation. Average and standard deviation were used in continuous descriptive variables.

RESULTS

One hundred and forty-eight eligible cases were treated during the 11 month time period; one case was eliminated because of the poor quality of the data obtained. Average age was 54 ± 22.6 years. In four cases (2.7%) the cause of the arrest could not be determined by the ambulance crews; 49 (33.3%) were considered as secondary to a cardiac cause, 46 (31.1%) were considered as caused by other diseases, 27 (18.4%) caused by severe trauma, 18 (12.2%) caused by a terminal illness and in 3

cases (2%) drowning was the cause of the arrest.

Table 3 shows the time intervals calculated from the times obtained.

<table>
<thead>
<tr>
<th>Intervals</th>
<th>Avg.</th>
<th>St.Dev.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collapse Assessment</td>
<td>0:22:52</td>
<td>0:19:13</td>
<td>109</td>
</tr>
<tr>
<td>Collapse to Call</td>
<td>0:09:31</td>
<td>0:34:09</td>
<td>122</td>
</tr>
<tr>
<td>Call to Arrival</td>
<td>0:13:56</td>
<td>0:10:43</td>
<td>137</td>
</tr>
<tr>
<td>Arrival to Patient Assessment</td>
<td>0:02:20</td>
<td>0:04:45</td>
<td>121</td>
</tr>
</tbody>
</table>

Table 3.- Time intervals shown in the city of Queretaro. (Fraga et al. 2009)

As an average (mean), patients were assessed by the EMS personnel in 23 minutes (±19 minutes) after collapse, with 10 minutes from collapse to ambulance notification, and 14 minutes from ambulance notification to arrival.

One arrest (0.7%) was witnessed by EMS personnel. Three cases (2%) CPR had been initiated by bystanders before the ambulance arrived. None of the patients received defibrillation before ambulance arrival. In one case (0.7%) the use of Implantable Cardioverter Defibrillator (ICD) was reported.

EMS personnel performed the following interventions, in the numbers shown:

- Thoracic compressions in 40 patients (27.2%)
- Endotracheal intubation or airway control in 32 cases (21.8%)
- Assisted ventilations, 26 cases (17.7%)
- Defibrillation in seven cases (4.8%)

Nine of the 148 cases (6%) did not have information about their state at the arrival to the hospital. Twelve (8.6%) of the patients had spontaneous circulation at the arrival to the hospital, nevertheless none of the patients was discharged alive. Table 4 shows a summary of these cases, using the modified/abbreviated Utstein template.

After analysing the data by logistic regression, neither the age nor the cause of arrest were predictive for return of spontaneous circulation. Thoracic compressions and airway management were predictive for the ROSC (75% vs. 25%, OR 8.5, CI 1.2-61.3, p<0.03 and 58.3% and 41.7%, OR 12.9, CI 1.3-130.4, p<0.03 respectively).

Table 4.- Results from Out-of-Hospital Cardiac Arrest using Utstein Template (Fraga et al. 2009) Initial rhythm was not reported in any of the ambulance reports, Cerebral Performance Category (CPC) was not measured based on the null survival rates, report about witnessed arrests before ambulance arrival was not provided.

After the logistic regression, defibrillation and ventilation demonstrated no correlation with ROSC. The realization of any kind of intervention (chest compressions, airway management, etc) was positively related with ROSC (OR 7.88, CI 2-30.8, p<0.003).

The interval patient collapse-patient assessment of less than eight minutes did not show a statistically significant difference in comparison with longer intervals regarding the chances of pulse recovery before hospital arrival (OR 1.6 IC 0.17-15.2, p>0.05).
OUTER OBSERVATIONS

It was particularly difficult to realise this research due to the lack of a strong research culture with the Mexican EMS system. This is consistent with experiences in other countries when EMS research has been initiated in immature systems. In more developed countries (speaking about EMS) research has been placed on the agenda for some time now (Lilja 2004, Delbridge et al. 2009, Sayre et al. 2001, Tippet et al. 2003) Most personnel involved in the EMS in Mexico are not involved in clinical research, as there are few quality management projects and thus the personnel are not accustomed to filling out forms and clinical records, although it is mandatory by law. In this particular research project we were not able to obtain all the core data recommended on the Utstein reporting style. Table 5 shows the core data recommended by the Utstein style (Jacobs et al. 2004) compared to the data we were able to obtain.

Table 5: Utstein Style recommended core Data (Jacobs et al. 2004) vs. Data (Fraga et al 2009).

When trying to analyse if there was any relationship between survival and EMT’s training, 100% of the providers reported to be trained as basic emergency medical technicians (EMT’s), and therefore it was not possible to analyse the relationship between the ambulance crew training with the survival rates. Information about EMT’s length of experience was obtained in 137 events. A total of 256 EMT’s reported their experience. The length of experience of the EMT with more experience was used as the basis for the analysis. It was found that the median for length of experience was five years (Min:1 year, Max:18 years, Quartile1:4 years, Quartile 3:5 years). Additionally it was found that patients treated by a team with equal or less than five years of experience had return of spontaneous circulation (ROSC) in 10 out of 131 cases (7.63%) of the events, while in the events treated by teams with more than five years of experience, the ROSC happened in 1 out of 6 cases (16.67%) with no significant difference (OR: 242). A more detailed analysis was performed by separating the group into three subgroups: low experience (4 years or less), medium experience (5 years), high experience (more than 5 years). Table 6 shows that patients treated by EMT’s with five years of experience had

significantly lower rates of ROSC (p <0.04). Figure 3 shows in detail the number of events in relation to the maximum crew’s length of experience and the ROSC rates. Further studies should be undertaken in order to define more clearly if this relationship is affected by other variables such as time to defibrillation, first rhythm, and other variables that might have affected the outcome in each group. This information cannot be generalized.

<table>
<thead>
<tr>
<th>Length of Experience</th>
<th>n</th>
<th>ROSC</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal or less than 4 years</td>
<td>69</td>
<td>9</td>
<td>13.04%</td>
</tr>
<tr>
<td>5 years</td>
<td>62</td>
<td>1</td>
<td>1.61%</td>
</tr>
<tr>
<td>More than 5 years</td>
<td>6</td>
<td>1</td>
<td>16.67%</td>
</tr>
</tbody>
</table>

Table 6.- Relation of the ambulance crew major length of experience and the number of patients with Return of Spontaneous Circulation (ROSC).

![Fig. 3 Relation of the Maximum Crew's length of experience and Return of Spontaneous Circulation (ROSC). LOE: Length of Experience.](image)

As mentioned earlier less than half the patients were treated by the responding EMT’s. This decision was not statistically related to the cause of neither the arrest nor the time intervals between collapse and patient assessment. Table 7 shows the relationship between the cause of arrest and the proportions in which ambulance personnel performed the different procedures (Chest compressions, defibrillation, ventilation and airway management).

<table>
<thead>
<tr>
<th>Procedure Realized</th>
<th>Chest compressions</th>
<th>Defibrillation</th>
<th>Ventilation</th>
<th>Airway Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>30.61%</td>
<td>0.00%</td>
<td>18.37%</td>
<td>18.37%</td>
</tr>
<tr>
<td>TRAUMA</td>
<td>22.22%</td>
<td>7.41%</td>
<td>18.52%</td>
<td>25.93%</td>
</tr>
<tr>
<td>Terminal Illness</td>
<td>33.33%</td>
<td>0.00%</td>
<td>22.22%</td>
<td>27.78%</td>
</tr>
<tr>
<td>Others</td>
<td>24.44%</td>
<td>8.89%</td>
<td>13.33%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Significance</td>
<td>0.77</td>
<td>0.12</td>
<td>0.83</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Table 7.- Procedures Realized by the ambulance personnel in relation to the cause of arrest.

Discussion

This report shows a surprisingly high mortality from out-of-hospital cardiac arrest in Queretaro, Mexico. Although we cannot generalise from these results for other regions of Mexico, the state of the health care services and EMS services (see previous chapters) is similar throughout the majority of the Mexican Republic.

Nevertheless some of the patients had return of spontaneous circulation and this appears to have been related to the interventions performed by the EMS providers. This supports the idea that increasing the capability of EMS providers in Mexico might increase survival from out-of-hospital cardiac arrest. From another point of view, although the results are not conclusive, the length of experience might also be related to ROSC with fewer cases of ROSC on patients treated by crews with five years of experience and higher rates of ROSC on events treated by crews with more than five years of experience or less than five years of experience.

On the other hand the results show what might be considered the most important areas of opportunity to improve outcomes. These are:

- Response times: as shown in this study, the time from collapse to ambulance activation was 9 minutes 31 seconds (st. dev. 34 mins) which might be related to a poor coordination among EMS providers or a not very strong unique emergency number, which can be enhanced. Although the ambulance response time was around 14 minutes as an average and might not be considered poor in contrast with the response times reported in Mexico City (Secretaría de Salud del Distrito Federal 2008) which are reported around 40 minutes; is far beyond usefulness according to the American Heart Association’s recommendations of providing defibrillation before 2 minutes after collapse (American Heart Association et al. 2000) especially considering the other community related factors discussed below. This can be achieved by centralised numbers, increased number of ambulances, better distribution and training and equipping of other safety agencies (e.g. Police) on the use of Automatic External Defibrillators.

- Low community participation: only in 2% of the cases the victim was receiving CPR by the time of ambulance arrival and in none of the cases a shock was administered before the ambulance arrival. This reflects the extremely low percentage of the population in Queretaro that receives CPR training and the non-existent Public Access defibrillation programs. Community training programs should increase in number and be simplified. For example, the recent recommendations of “Hand-only-CPR” can be used to design massive oriented, low cost training courses to a more extensive number of people in the population. (Sayre et al. 2008).

On the other hand, in this study no statistical differences were found related to the decision not to initiate CPR manoeuvres, neither in the groups defined by the different arrest causes, nor by the time intervals between collapse and patient assessment. This reflects the low capacity of the EMS providers in the city of Queretaro to make this decision, based on clinical data. It might also be due to the lack of standard medical advice in relation to cardiac arrest.

Patients with asystole as first presenting rhythm have a poorer prognosis compared to those with ventricular fibrillation or ventricular tachycardia (Agarwal et al. 2009). Also patients with trauma have a very poor prognosis (Soar et al. 2005). In this study we could determine that about 18.4% of the patients in cardiac arrest were of possible Traumatic aetiology, but could not determine the initial rhythm because of the lack of information on the ambulance records. The high mortality rate (100%) did not allow us to compare the outcomes in patients in cardiac arrest from different aetiologies.

This was a local study that might not reflect the national problematic, but the details shown in other chapters suggest the possibility of similar results in other Mexican cities. It also lacks some information regarding aspects of the Utstein definitions because all data came from prehospital care charts that did not include such data. For future research projects it might be useful to:

- Create prehospital forms to be filled by EMTs while treating or just after treating Out-of-Hospital Cardiac Arrests
- Include in the actual forms information regarding Utstein Style analysis of cardiac arrest
- Propose a change in the actual Legislation (see EMS systems in Mexico) to include Utstein Style data as an obligatory aspect of prehospital care records
- Develop real time systems for data capture and analysis

Conclusions

Mortality from out-of-hospital cardiac arrest in Queretaro, Mexico is very high due to several reasons:

1. Low percentage of the patients receiving CPR by lay rescuers
2. Long response times by the ambulance services
3. Low rates of procedures performed by the ambulance services

Nevertheless, all those aspects can be enhanced by interventions. Others, like the experience of the ambulance crew members and the efficiency of the emergency numbers, need a more profound revision. All these interventions will be discussed in detail in the last chapter.

APPENDIX 1
Selected Utstein Style definitions (Jacobs et al. 2004)

**Arrest, Witnessed:** A witnessed cardiac arrest is one that is seen or heard by another person or an arrest that is monitored.

**Assisted Ventilation:** The act of inflating a patient’s lungs by rescue breathing with or without a bag-mask device or any other mechanical device.

**Attempted Defibrillation:** Defibrillation can be attempted by means of an automated external defibrillator (AED), a semi-automated external defibrillator, an implantable cardioverter-defibrillator (ICD), or a manual defibrillator. The type of device used is not considered a core data element.

**Bystander CPR:** CPR performed by a person who is not responding as part of an organised emergency response system approach to a cardiac arrest. Physicians, nurses and paramedics may be described as performing bystander CPR if they are not part of the emergency response system involved in the victim’s resuscitation.

**Cardiac Arrest:** The cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation. If an EMS provider or physician did not witness the cardiac arrest, then the professional may be uncertain as to whether a cardiac arrest actually occurred.

**Cause of Arrest (Aetiology):** An arrest is presumed to be of cardiac aetiology unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguinations, or any other non-cardiac cause as best determined by rescuers.

**Chest Compressions:** Chest compressions are performed by an individual or a mechanical device during CPR in an attempt to restore spontaneous circulation.

**Cardiopulmonary Resuscitation:** CPR is an attempt to restore spontaneous circulation by performing chest compressions with or without ventilations.

**Date of Arrest:** The date the event was known to occur or the date on which a patient was found. This date should be recorded in a conventional format that is consistent for the region.

**Date of Birth/Age:** If a patient’s date of birth is known, it should be recorded in an acceptable format. If the date of birth is not known but the patient’s age is known, then the age should be recorded. If the patient’s age is not known, his or her age should be estimated and recorded.

**Date of discharge/death:** The date on which the patient was discharged from the acute hospital or was certified as dead. It should be recorded in an acceptable format.

**Drugs:** The term “drugs” refers to the delivery of any medication (by intravenous cannula, intra-osseous needle or tracheal tube) during the resuscitation event.

**Emergency Medical Services:** EMS personnel respond to a medical emergency in an official capacity as part of an organized medical response team. By this definition, physicians, nurses, or paramedics who witness a cardiac arrest and initiate CPR but are not part of the organized rescue team are characterized as bystanders and are not part of the EMS system.

End of Event: A resuscitation event is deemed to have ended when death is declared or spontaneous circulation is restored and sustained for 20 minutes or longer. If extra-corporeal life support is being provided, then the end of event is 20 minutes after extra-corporeal circulation has been established.

First Monitored Rhythm: The first monitored rhythm is the first cardiac rhythm present when a monitor or defibrillator is attached to a patient after a cardiac arrest. If the AED does not have a rhythm display, then it may be possible to determine the first monitored rhythm from a data storage card, hard drive, or other device used by the AED to record data. If the AED has no data-recording device, then the first monitored rhythm should be classified simply as shockable or non-shockable. This data point can be updated later if the AED has data download capability.

Location of Arrest: The specific location where the event occurred or the patient was found. Knowledge of where cardiac arrests occur may help a community to determine how it can optimize its resources to reduce response intervals. A basic list of predefined locations will facilitate comparisons. Local factors such as the following may make the creation of subcategories useful:

- Place of residence (e.g., home, apartment, back yard of a home)
- Public Place (e.g., street, city park, shopping centre, sports stadium, entertainment centre, airport, railway stations, church, beach, office building)
- Other (e.g., hotel room, private office, long-term care facility)

Neurological Outcome at Discharge from Hospital: Documentation of a patient's neurological status at many specific points is desirable (e.g., on discharge from the hospital, at 6 months, at 1 year); however, recording neurological outcomes after discharge has been difficult. Survival without higher neurological function is suboptimal; therefore, it is important to attempt to assess neurological outcome at discharge. A simple validate neurological score such as the Cerebral Performance Category (CPC) should be recorded, if available.

Patient Identifier: is a unique numeric or alphanumeric sequence that identifies a specific patient and cardiac arrest event. Ideally, the patient identifier should stay with the patient from the resuscitation event to hospital discharge (recovery or death). Unfortunately, few systems have the ability to link individual patient care records for the out-of-hospital, in-hospital, and post-discharge phases of the event.

Resuscitation: A resuscitation attempt is defined as the act of attempting to maintain or restore life by establishing or maintaining airway (or both), breathing, and circulation through CPR, defibrillation, and other related emergency care techniques.

Resuscitation Attempt by EMS Personnel: When EMS personnel perform CPR or attempt defibrillation, it is recorded as a resuscitation attempt by EMS personnel.

Resuscitation not attempted by EMS Personnel: EMS personnel may not attempt resuscitation when a do-not-attempt-resuscitation (DNAR) order exists, a resuscitation attempt is considered futile, or resuscitation is not required.

Return of Spontaneous Circulation: Signs of the return of spontaneous circulation (ROSC) include breathing (more than an occasional gasp), coughing, or movement. For healthcare personnel, signs of ROSC also may include evidence of a palpable pulse or a measurable blood pressure. For the purposes of the Utstein registry template, “successful resuscitation” or ROSC is defined for all rhythms.

as the restoration of a spontaneous perfusing rhythm that results in more than an occasional gasp, fleeting palpated pulse, or arterial waveform. Assisted circulation (e.g., extra-corporeal support such as extra-corporeal membrane oxygenation or a bi-ventricular assist device) should not be considered ROSC until “patient-generated” (i.e., spontaneous) circulation is established. Previous reports that focused on outcomes from ventricular fibrillation have variably defined “successful defibrillation” as the termination of fibrillation to any rhythm (including asystole) and the termination of fibrillation to an organized electrical rhythm at 5 seconds after defibrillation (including pulseless electrical activity [PEA]). Neither of these definitions of successful defibrillation would qualify as ROSC unless accompanied by evidence of restored circulation. By consensus, the phrase “any ROSC” is intended to represent a brief (approximately >30 sec) restoration of spontaneous circulation that provides evidence of more than an occasional gasp, occasional fleeting palpable pulse, or arterial waveform. The time at which ROSC is achieved is a core data element.

Sex: (male or female) may be an important risk factor for cardiac arrest and resuscitation interventions.

Shockable/Non-shockable Rhythm: Shockable/non-shockable rhythm refers to the first monitored rhythm, which when analysed by the person interpreting the monitor/defibrillator or an AED, was found to be treatable by attempted defibrillation (i.e., shockable or non-shockable). In general, shockable cardiac arrest rhythms are further divided into ventricular fibrillation and pulseless ventricular tachycardia. Non-shockable cardiac arrest rhythms can be categorized as either asystole or PEA. Although a specific definition of asystole is desirable, no consensus agreement was reached on either a specific duration (e.g., 30 seconds) or heart rate (e.g., <5 b.p.m) to define asystole versus bradycardia/PEA. In future iterations of the registry document, further consideration and additional research resources may need to be devoted to addressing the importance and ability of providers to differentiate between these initial cardiac rhythms.

Successful CPR before EMS Arrival: Occasionally when a bystander witnesses a cardiac arrest and starts CPR, the patient will regain signs of circulation by the time EMS personnel arrive. If the bystander verifies that the patient had no signs of circulation and that CPR was performed, a registry record should be initiated. EMS personnel do not need to verify that a cardiac arrest occurred for this case to be included in the registry.

Survived Event: for the out-of-hospital setting means sustained ROSC with spontaneous circulation until admission and transfer of care to the medical staff at the receiving hospital. For the in-hospital setting, survived event means sustained ROSC for >20 minutes (or the return of circulation if extracorporeal circulatory support is applied).

Survival to Hospital Discharge: Survival to hospital discharge is the point at which the patient is discharged from the hospital’s acute care unit regardless of neurological status, outcome, or destination.

Sustained ROSC: is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist (or sustained ROSC if extracorporeal circulatory support is applied). Thus, after resuscitation from in-hospital cardiac arrest, sustained ROSC and survived event have the same definition.

APPENDIX 2
Approval letter. Charles Sturt University. Ethics Committee.

[Image of the approval letter]

11 April 2006

Dr Juan Manuel Fraga
Paseo Jurica 105-25PB
Jurica
Queretaro
MEXICO 76100

Dear Dr Fraga,

The Ethics in Human Research Committee has approved your proposal “Relationship between out-of-hospital cardiac arrest outcomes and ambulance crewing and equipment” for a twelve month period from Tuesday, 11 April 2006.

The protocol number issued with respect to this project is 2006/081. Please be sure to quote this number when responding to any request made by the Committee.

Please note that the Committee requires that all consent forms and information sheets are to be printed on Charles Sturt University letterhead. Students should liaise with their Supervisor to arrange to have these documents printed.

You must notify the Committee immediately should your research differ in any way from that proposed.

You are also required to complete a Progress Report form, which can be downloaded from www.csu.edu.au/research/forms/ehrc_annrep.doc, and return it on completion of your research project or by 11/04/2007 if your research has not been completed by that date.

The Committee wishes you well in your research and please do not hesitate to contact the Executive Officer on telephone (02) 6338 4628 or email ethics@csu.edu.au if you have any enquiries.

Yours sincerely

Julie Hicks
Executive Officer
Ethics in Human Research Committee

**APPENDIX 3. DATA RECOLLECTION FORM. For this study**

No.: 

**Date of Arrest:** (DD/MM/YYYY)

**Name of the Patient:**

**Address:**

**Neighborhood:**

**Gender:** Male ( ) Female ( )

**Phone:**

**Age:** ____ Years (estimated) or **Date of Birth:** (DD/MM/YYYY):

**Cardiac Arrest Determined by:**

**Cause of the Arrest (if known):**

**Treatment Previous to EMS arrival**

- Lay Person CPR ( )
- Defibrillation by Layperson ( )
- Implanted Defibrillator ( )

**Ressuscitation attempted by EMS**

**Location of Arrest:** Out-of-Hospital ( ) in Hospital ( )

**Witnessed:** Yes ( ) No ( )

**If Witnessed, Time of the Arrest:** (HH:MM):

**Initial Rhythm (if known):**

**Chest Compressions:** YES ( ) NO ( )

**Time when they began (if known):** (HH:MM):

**Defibrillation attempt:** YES ( ) NO ( )

**Time of first discharge (if known):** (HH:MM):

**Ventilation:** YES ( ) NO ( )

**Time where it began (if known):** (HH:MM):

**Advanced Airway Management:** No ( ) Endotraqueal tube ( )

**Esofaegal obturation ( ):**

**Drugs (Drug and Time of Administration):**

**Time of Colapse:** (HH:MM) (Estimated):

**Time of call receipt:** (HH:MM):

**Time vehicle stopped:** (HH:MM):

**Time of first rhythm analysis:** (HH:MM):

**Spontaneous Circulation (on Arrival to ED):** Yes ( ) No ( )

**Hospital Admission:** Yes ( ) No ( )

**Hospital Discharge:** Yes ( ) No ( )

**¿Declared Death?** Yes ( ) No ( )

**Date of Hospital Discharge (o muerto):** (Dia/Mes/Año):

**Neurologic Status ad discharge (CPC):**

**Ambulance Personnel:**

<table>
<thead>
<tr>
<th>No</th>
<th>Posición</th>
<th>Nivel*</th>
<th>ACLS or Equiv</th>
<th>Univ. Degree**</th>
<th>Courses ***</th>
<th>Age</th>
<th>Exp.</th>
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<td></td>
</tr>
</tbody>
</table>

* Students or Non-Technicians leave blank. MDs, write M. Nurses write E.
** If the EMT title was obtained as a University Level.
*** Other Courses T = Trauma (PHTLS/BTLS), M = Medical (BLS, AMLS), Q = Burns (ABLS, etc). Age = Age in years. Exp. = Years of Experience

CONSENT FORM
CARDIAC ARREST RESEARCH

Cruz Roja Mexicana. Delegación Santiago de Querétaro
Asesores en Emergencias y Desastres
Charles Sturt University.

I, ________________________________ have been informed about the research that is being happening and I agree that they use the collected information on this form with statistical purposes.

I have also been informed, by the personnel that is attending my family member, about the same facts:

• This research only includes the collection of data about the attention provided to my family member.
• This event has a bad prognosis itself and this research doesn’t modify the prognosis out of this situation, nevertheless this information might help to improve these kind of services in the future.
• There is no experimentation with any kind of drug or procedure.
• The information will be maintained in a confidential manner and only people involved in the research project will have access to it.
• THERE IS NO FURTHER RISK TO MY FAMILY MEMBER DERIVED FROM THIS RESEARCH.

The institutions that participate in this research are:

• Cruz Roja Mexicana. Delegación Santiago de Querétaro. With Data recollection.
• Asesores en Emergencias y Desastres. With the research design and analysis.
• Charles Sturt University en Australia. Is the institution that endorses this research.

I was informed that I can contact Dr. Juan Manuel Fraga who is responsible for this research for further information. His phone is (442) 2184424 during afternoons.

I received a printed copy of this information.

Name, Signature and Relationship                      Witness

NOTE: Charles Sturt University’s Ethics in Human Research Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

The Executive Officer
Ethics in Human Research Committee
Academic Secretariat
Charles Sturt University
Private Mail Bag 29
Bathurst NSW 2795

Tel: (02) 6338 4628
Fax: (02) 6338 4194

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.
This document has the aim of informing about the research that is being happening and that will be benefited from the data obtained from the attention to your family member.

This is a research based on the information about the attention and NOT a procedure or medication used during the attention. It is worth mentioning that:

• This research only includes data recollection about the attention that your family member received.
• The event has bad prognosis itself and this research doesn’t modify it. Nevertheless the data obtained might help to improve this kind of services in the future.
• There is no experimentation with any kind of procedure or drug.
• The information will be maintained in a confidential manner and will only have access to it those involved in the research study.
• THERE IS NO KIND OF RISK TO MY FAMILY MEMBER DERIVED FROM THIS RESEARCH.

The participating institutions are:
• Cruz Roja Mexicana. Delegación Santiago de Querétaro. With data collection.
• Asesores en Emergencias y Desastres. With research design and data analysis.
• Charles Sturt University en Australia. Is the institution that endorses this research.

For more information you can contact Dr. Juan Manuel Fraga who is responsible for this research. His phone number is (442) 2184424 on the afternoons.

NOTE: Charles Sturt University’s Ethics in Human Research Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

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Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Reference List


Conclusions and Recommendations

From Context to Outcomes

Mexico is a very rich and diverse country with many ecosystems throughout its 32 states that have very heterogeneous climates, economies and political environments. It cannot be assumed that what happens in one Mexican state happens in others. However, from the evidence cited in previous chapters some assumptions can be made that allow reflection on the findings of this study that will raise some questions about the EMS systems in other states. As a result of this study, other researchers may be encouraged to increase the publication rate in relation to the Emergency Medical Services (EMS) systems performance and EMS systems opportunities in Mexico.

According to the Panamerican Health Organization (PAHO, 2008) the Gross National Income per capita in Mexico is U$7,310.00 dollars per year, occupying a leading place in Latin America but far behind its northern neighbours USA (GNI per capita U$43,560.00) and Canada (GNI per capita U$32,590.00). Even within Mexico there are extreme differences among the different regions in the country, with states like Nuevo Leon (north of the country) having a GNI that is almost five times that of Chiapas (south of the country) - occupying places 2nd and 30th respectively (Centro de Estudios sobre Finanzas Públicas. Cámara de Diputados, 2005).

These differences are also reflected in the health status of the population in each state. Table 3 in chapter 2 illustrated these differences on the grouped mortality rates between Chiapas (southern Mexico), Queretaro (central Mexico) and Nuevo Leon (northern Mexico). While mortality rates are higher for accidents and infectious diseases in Chiapas, they are higher for non infectious diseases in Nuevo Leon. Nevertheless, at a national level Diabetes Mellitus and Ischemic Heart Disease are the two leading causes of death in the country, with stroke, accidents and other traumatic health problems also occupying some of the first 20 leading causes of death (Direccion de Informacion en Salud, 2007).

From a local perspective not all members of the population have the same opportunity to receive health care services in Mexico as stated in chapter 2. The public health care system is divided into several subsystems and is complemented by privately operated health care services focused on the population who have the possibility to pay for services directly or through private health insurance. As a result a high proportion of the population has limited access to any kind of service and sometimes the quality of these specific services is poor (eg. Public Health services in Queretaro). The best possible treatment for a particular health related problem, such as angioplasty for cardiac infarction is not available to many people because of their lack of financial resources.

These access and equity disparities in the overall hospital-related health care services are well understood, however little attention has been given to the pre-hospital care services. This lack of attention is reflected in the small number of research publications on pre-hospital care that are accessible through Pubmed and other academic databases (chapter 3).

One study completed in Queretaro and published internationally reported a 0% survival rate from out-of-hospital cardiac arrest (OHCA). However, the study also identified some major areas of opportunity to improve this outcome (Fraga, 2009):

A low percentage of the victims were receiving CPR when the ambulance arrived at the scene

No victim received defibrillation prior to the ambulance arrival

Response times were slow

The number of relevant procedures carried out by the ambulance crew members was low (in less than 30% of the victims).

It is important to mention that Queretaro is the only city in Mexico where there is any kind of follow up to cardiac arrest victims. This situation is not an isolated problem or one restricted to Mexico, with the Resuscitation Academy’s web site (2009), reporting that only 40 communities in the USA are measuring and reporting the survival rates from out-of-hospital cardiac arrest. The message here is that if the problem has not been identified, it is hard to solve it.

Other outcomes from Pre-hospital Care have been measured in Mexico, of which, one is trauma mortality. While Mexico is performing better than some other countries such as Ghana, in terms of mortality rates from trauma, there are still opportunities for improvement in comparison with the USA (Mock et al 1998). In 2006, Arreola and colleagues analysed the capacity of different level hospitals in states in three different regions in Mexico, finding a shortage of supplies and treatment in comparison with World Health Organisation recommendations for the essential trauma care in Mexico. They suggest that most of these shortages are low cost areas of opportunity that can improve the outcomes of the trauma victims. Amongst their recommendations, especially in small clinics, were Advanced Trauma Life Support training for junior physicians, equipment with pulse oximetry, cardiac monitoring and appropriate patient registering.

Similarly, the low survival rates from out-of-hospital cardiac arrest in Queretaro and Mexico in general (Fraga et al 2009), as well as other clinical problems, might be improved through appropriate interventions in the EMS and hospital systems (Mock et al 1998). While some interventions may be low cost and others more expensive, continuing to measure actual outcomes in different Mexican communities and measuring the impact of different interventions would help to establish efficient, cost-benefit interventions that translate into improved survival rates, better access to health care services (especially in emergencies) and a more healthy community.

Lilia’s framework, described in chapter 3, will be used to analyse the areas of opportunity for improvement that Queretaro (and maybe other Mexican communities) may be able to implement. Following this analysis and reference to the relevant literature, recommendations for improvement will be made.

Personnel

There are important differences between the ambulance crew members in Mexico and what is assumed in the world literature about the profile of ambulance personnel. The following personnel differences between Mexico and comparable countries such as the USA have been established:

• Few members are contracted and receiving a salary (Areola-Risa et al 2002, Fraga 2004 and

• Low frequency of performing pre-hospital care skills (e.g. Endotracheal intubation) (Fraga 2004).

It has been reported that the length of experience among personnel has been associated with better achievement on certain tasks such as endotracheal intubation (Wang et al 2005, Garza et al 2003), and with better survival rates (Gold et al 2009), although based on the research completed in Queretaro, the reasons for this have not been clearly established (chapter 4).

The two strategies, identified at the federal level as a “best-practice” to be followed in relation to improving the competence of EMS personnel are (CENAPRA 2008):

- Training of rescue organizations
- Periodic re-certification of Emergency Medical Technicians (EMTs) and continuing education.

There is a good argument that in order to improve personnel retention and skill levels a greater effort should be made to train EMS personnel at higher levels and to maintain their skills through continuing education. While it is not currently possible to prove that the retention of these talented personnel might be related to a positive change in outcomes, there would certainly be a saving in recruitment and training costs. According to the Aberdeen group (2005) some factors that might contribute to better retention are:

- At corporate level
  - Better working conditions
  - Job security
  - Interesting work
  - Competitive benefits
  - Competitive salary
- Developmental level
  - Recognition for work well done
  - Opportunity for education/training
  - Opportunity for advancement/growth
  - Work/life balance
  - Manager-employee relationship
- Company-employee interaction
  - Sympathetic help on personal problems
  - Employee involvement in decision making, inclusiveness
  - Tactful, constructive discipline, performance suggestions
  - Personal loyalty to workers

The number of employed EMTs and paramedics should grow, to become a major proportion of the actual EMS providers. As explained in Chapter 3, EMS providers that receive a salary in Mexico have more experience in terms of time dedicated during the week and the years of experience within the system. Gold (2009) reported that the experience of the paramedic treating the patient (realising procedures) is related to the overall survival from out-of-hospital cardiac arrest. This is not a problem exclusively for Mexico as Erich (2001) states: there is a big need not only for people with training and experiences, but in sufficient numbers in the North American Context “When Home Depot’s stealing your best people, you know you’ve got trouble” reflecting the need for a dignifying salary and a career

opportunity for those working around the EMS systems.

In Canada the need to improve staffing and career development has also been identified (Emergency Medical Services Chiefs of Canada, 2006). They recommend six key strategic directions that will enable a “positive and controlled movement” toward the vision they defined that includes having stable funding, personnel development and leadership support all related to personnel aspects of EMS systems.

Training

Throughout the world ambulance crew training is very diverse and while there are published standards, such as in the United States’ standards from the Department of Transport (at the National Highway Traffic Safety Agency - NHTSA), these standards were developed more than a decade ago. In 1995 for Emergency Medical Technicians and 1998 for paramedics. An ideal professional profile has also been defined in Canada (Paramedic Association of Canada 2007). They have defined three different kinds of assessment and educational settings for the competencies through:

• preceptorship,
• Clinical experience and
• simulation (Canadian Medical Association 2007).

Nevertheless new documents like the EMS Agenda for the Future (Delbridge 2009) demonstrate a new perspective where the ambulance crew member’s training should be moving in the future, with an emphasis on professional education at higher education institutions with emphasis on placing research and administration as part of the curriculum. In Australia, Willis and colleagues (2009) have just published a report on Paramedic Education trying to answer two fundamental questions:

What can be learnt from international pre-hospital service providers, professional associations, universities and the research literature that might contribute to meeting the future educational needs of paramedic graduates in Australia?

What international and national models of collaboration and working relationships between ambulance service providers, professional associations and universities offer best practice examples for fostering an ideal working relationship for the education of future paramedics?

After a profound analysis on the education of paramedics at higher education levels and consideration of how the health care sector is changing, national and international education trends, experiences in nurse education, paramedic education and many other factors, the authors identify tertiary education as the key to developing multidisciplinary, technical literacy and more importantly have an impact over actual outcomes. As they mention in this extensive report, the paramedic profile is changing with the health care needs and tertiary, multidisciplinary institutions, are the best places in which to provide the evidence based education for paramedics that meet the actual needs of society (Willis and colleagues 2009).

In the United Kingdom, similar reflections have yielded ideas to improve the role of EMS systems in aspects (Ambulance Service Network 2008) such as:

• Paramedics being able to transmit 12 lead ECGs and by passing the Emergency room to take

the patient directly to the Cath-labs
- Handsets that transmit information from patients to an ambulance service and when something is not normal with an ambulance is sent to verify the condition of the patient.
- Telephone assessment of the patients
- The creation of Urgent Care Services that apart from the actual EMS capacities they also are capable of providing some primary care services

These developments are expanding the vision of EMS roles within the health care system and making it a more important player in primary care and secondary prevention beyond the Emergency Response. Some paramedic roles have emerged with names such as: Community Paramedics, Critical Care Paramedics, Intermediate care paramedics, A & E paramedics, Treat and Refer Paramedics (Ball, 2005).

This enhanced vision can also be useful in remote or rural areas where physicians are scarce. In Australia, several models have been defined and numerous examples are identified by Blacker and colleagues (2009) in New South Wales, Queensland, Victoria, South Australia, Tasmania, Western Australia and in Northern Territory with diverse roles.

On the other hand, in Europe in countries such as Germany and France are using more physicians in the EMS systems who are integrated within their hospitals, with the same physician sometimes managing the patient throughout both the prehospital phase and the hospital phase of their treatment (Dick 2003).

While the latter is more documented in urban European settings, the first examples are well documented in rural, disperse or lower income communities where non-medical professionals have an important role in increasing health care access. Mexico has still to learn from the international lessons to define which pathway will yield not only better EMS system but also a better-integrated and more accessible health care system.

In Mexico, little consideration has been given to pre-hospital care professional education and training. At the federal level, the General Health Law (Ley General de Salud) was reformed to include in Article 79 the obligation for pre-hospital care personnel to have a diploma given by an educational institution recognised by law. On the other hand the national standard on emergency ambulance services (NOM-237-SSA1-2004) published in 2005, establishes the competences for basic, intermediate and advanced EMTs. Currently there are only five higher education institutions in the country providing education to pre-hospital care providers that are recognised by the Education Secretariat and provide for education at a tertiary level (equivalent to professional associate). The remainder of EMTs and paramedics are trained within the institutions that employ them. It is possible that this number represents around 300 basic EMT courses, 100 intermediate EMT courses and 50 paramedic courses in the country, without any recognition, supervision or registry provided (Fraga 2007 and chapter 3).

The actual training of EMTs in Mexico is mostly equivalent to basic EMT with few advanced life support providers nationwide. In Queretaro, none of the ambulance providers that treat out-of-hospital cardiac arrest have had a level of training beyond basic EMT (chapter 4).

There is no obligation in Mexico for ambulance crew members to participate in continuing medical education, even though it has been suggested by Arreola-Risa and colleagues (2004) that implementation of such programs would reduce the mortality rates amongst trauma patients.

Formal studies are mainly provided when there is an opportunity to professionally dedicate someone’s life to a discipline. As explained earlier, only half of the pre-hospital care providers nationwide receive a salary and their professional lifespan is very short (5 years). Professional education should be developed hand in hand with the development of professional scope of practice where using the competences acquired during the formal education is encouraged and authorised. In Queretaro and Mexico generally, emphasis needs to be placed on the financing of a professionalised pre-hospital care service as well as the development of higher education opportunities for those working or willing to work in the field. As mentioned earlier, these transformed services would affect the outcomes based on better experience and lifelong learning processes within the EMS community.

In light of the evidence that an experienced and well trained workforce can improve quality of care and clinical outcomes, efforts should be made to modify the actual pre-hospital care model to a self sustainable model that includes well paid and satisfied workers who are educated through higher education institutions. The current models, that are predominately volunteer based, with low or no salaries will result in high personnel turnover, low retention of talented personnel, low education expectations, low community expectations, low trust in pre-hospital care services. This scenario can then become a vicious circle that adversely affects mortality in time dependent, high severity cases, such as cardiac arrest.

In relation to the Human Resources the EMS Agenda for the Future group (Delbridge, 2009) recommends the following in the context of the US:

- Ensure that alterations in expectations of EMS personnel to provide health care services are preceded by adequate preparation.
- Adopt the principles of the National EMS Education and Practice Blueprint.
- Develop a system for reciprocity of EMS provider credentials.
- Develop collaborative relationships between EMS systems and academic institutions.
- Conduct EMS occupational health research.
- Provide a system for critical incident stress management.

And in relation to education:

- Ensure adequacy of EMS education programs.
- Update education core content objectives frequently enough so that they reflect EMS patient health care needs.
- Incorporate research, quality improvement, and management learning objectives in higher level EMS education.
- Seek accreditation for EMS education programs.
- Commission the development of national core contents to replace EMS program curricula.
- Conduct EMS education with medical direction.
- Establish innovative and collaborative relationships between EMS education programs and academic institutions.
- Recognize EMS education as an academic achievement.
- Develop bridging and transition programs.
- Include EMS-related objectives in all health professionals education.

While at this time, the Mexican EMS would be unable to fully implement all these human resources and educational recommendations, there are a number of steps that can be taken to address the broader 14 elements of the United States EMS Agenda for the Future within the constraints of the

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local situation. The steps that could be reasonably considered are explored below, within the Agenda for the Future Framework. Other frameworks might also been considered such as the Canadian proposal defined in 2007. (Canadian Medical Association 2007, Paramedic Association of Canada 2007)

Communications

Shortcomings in the EMS communications system have been identified as a major obstacle to the development of the EMS systems, with particular concern identified in those systems that are fragmented (Eisenberg 2009). Nevertheless, in the United States and elsewhere systems are being introduced to provide caller identification and location to the Public Safety Answering Point (PSAP) through the emergency telephone systems such as 911. The integration of technology to use standard means of communication and the use of information technology to provide the responders with information about the patient that can be integrated with information from other public safety and health agencies is strongly recommended in the Agenda for the Future (Delbridge 2009). Nevertheless the idea of a perfect system cannot be generalized. As Erich (2001) states, there are still many issues to be solved beyond the 911 emergency number in order for it to work properly in the United States.

On the other hand, in the United Kingdom more versatile uses of the communications are being discussed, such as increasing medical advice through the telephone system, checking on patients in a programmed manner and sending an ambulance in the cases where there is something apparently wrong (Bradley 2005, Ambulance Service Network 2008). They are considering a single point of access that divides the calls in two numbers 999 and “247”, the first oriented to emergency, life threatening situations whilst the last oriented to urgent, non-life threatening situations.

In Mexico, there are at least two 3-digit emergency numbers at the national level: 066 and 065. The first is administered by the security agencies nation-wide, the second is a number owned by the national Red Cross and administered at the local branch level with varying levels of technology and integration with the existing communities’ emergency response numbers. Apart from these two numbers, municipalities have other 3-digit numbers, such as 080, that provide emergency services. As previously noted, around 40% of the pre-hospital care services nationwide respond to existing emergency numbers and 70% to their own (7 or 8 digit) emergency number, most of the times having more than one option to activate them.

Some of the international communication strategies represent possibly a high investment cost, but in the long term they might represent a saving in terms of quality of care, differentiated level of care and improved clinical outcomes. A specific improvement would be in the provision of real time patient data transfer from ambulances to receiving hospitals. The potential to have a system based on actual, real, trustworthy data may result in long term savings that pay for themselves. On the other hand, the interventions that are implemented on the basis of the data may be translated into saved lives and the associated economic savings (Eisenberg 2009).

In the short term, some low-cost interventions can be implemented. These could include:

- Use of a single emergency number (initially other numbers can be redirected to the “official” one and resources concentrated there).
- Use of established radio frequencies to increase coordination between ambulance services and hospitals. For example establish dedicated channels for medical direction and

communication with hospitals, and established channels for medical dispatch.

- Voice recording of medical dispatch and medical attention for quality improvement purposes.
- Better dispatch training and the establishment of dispatch standards such as the dispatch of an ambulance within one minute after an emergency call is received.
- Dispatch assisted telephone CPR training to all emergency dispatchers.
- Dispatcher based triage and differentiation of the level of response depending on the specific situation.

Some of these recommendations are also synthesised by Eisenberg (2009). It is possible that the most important aspect is the willingness of certain stakeholders to facilitate financing, legislate and/or lead these changes.

Higher cost interventions in the EMS might consider:

1. Real time patient data-transfer.
2. Geo-localisation of ambulances using GPS technology.
3. Enhanced Emergency Numbers (that provide dispatchers with the location of the victim when answering).
4. Telemetry of vital signs, ECGs, etc.

All of these interventions, when implemented in a coordinated manner, may reduce response times, increase coordination and make patient information available for better management of the EMS system.

Transportation, Facilities and Finances

When analysing the operational and financial structure of ambulance services in Mexico, this study found that 31% are volunteer based NGOs, with 21% financed by the government and 33% private services, while 9% were a combination of the previous categories and 6% didn't answer this question on the survey. The balance of funding sources varies throughout the world. For instance, in Victoria, Australia the EMS system has 51% of their revenue from the government funding, 20% from service subscriptions, 20% from patient transport fees and 10% from other sources and 63% of their expenditure is related to personnel related expenses (Salaries, Allowances, Super and Work Cover).

In Queretaro, Mexico a large percentage of the pre-hospital care is provided by the local branch of the Red Cross which is an NGO with 32 salaried staff and around 80 volunteers. Most of the remaining pre-hospital care in the city is provided by volunteers. The local branch of the Red Cross in Querétaro has a budget of 10 million pesos (US$800,000.00 dollars) for the year 2010. Of the budget, 32% will come from donations that society gives when playing transit related infringement tickets ($60.00 pesos/US$5.00 dollars per ticket), 8.5% from donations made by society once per year, 3% from donations from enterprises and 57% from revenue generated by the medical services, training and non-emergency ambulance services. None of the revenues comes from government funding. (Cruz Roja Mexicana Delegación Santiago de Querétaro. 2010). Forty-eight percent of the expenditure is related to Personnel Services while the rest is dedicated to other expenses.

This situation can be misleading as it generates the appearance that there are enough vehicles (without judging the physical state they are in) and crews available when the times and days they work may leave hours of the day and week uncovered. This is of most concern during weekday nights.

from Monday to Thursday. The Queretaro EMS system is fragmented and often unregulated, even when some kind of standard exists.

According to Eisenberg (2009) fragmented systems have poorer outcomes than those with single dedicated services, or at least unified systems, and initial steps need to be undertaken to build local support through the establishment of pre-hospital care coordinating committees. These committees might consider having among its members, government authority and the active support of ambulance services, health and safety agencies and representation from the public. These committees should work under medical guidance (Eisenberg 2009, Delbridge 2009) to ensure that medical care, equipment and communication systems meet acceptable standards.

The experience of building such committees has also been used in other countries such as Australia (O’Meara, 2004) where after building a community based committee a rural local EMS was enhanced and governmental support was received in part because of the collaboration of the society that yielded in benefits such as:

- Elevated community cohesiveness
- Shared values, aspirations and goals
- Community engagement into the political and policy processes which forced the government departments to accept a community driven process (O’Meara, 2004)

EMS Critical Care Units

There is a national standard definition of how an EMS Critical Care Unit should be equipped and staffed. Decisions need to be made about whether these units should be staffed by EMTs trained in advanced life support or with specially trained physicians as is the case in many European countries (Dick 2003). These critical care units would then need to be coordinated with the rest of the EMS system and the overall emergency medical services system at the local, regional and national levels. It is particularly important to put in place a coordinated system when there is continuing debate around the world on which EMS system, a Tiered, non-tiered, BLS, or ALS - works best (Stiell 1998, 2008, Eisenberg 2009). Irrespective of developments in other countries, Mexico needs to base its models of service delivery and standards of performance on local needs, information and research findings.

Public Safety Agencies

With only a few exceptions, there are no laws and standards that regulate the relationships between EMS organisations and public safety agencies, such as fire squads, police agencies or other public safety agencies. One exception is in Mexico City and Cuernavaca (1 hour south of Mexico City in the state of Morelos) where the Police have their own ambulance service. Unlike the United States, very few fire brigades have ambulances and they represent a low percentage of the pre-hospital care providers in Mexico.

As mentioned in Chapter 3, public security agencies in Mexico have big budgets to deal with organised crime, and have therefore developed very good organisational infrastructure, technology and information systems. They also have more professional members within their staff establishment, as well as more vehicles and better response times. Eisenberg (2009) suggests that training police officers in first aid and CPR, then equipping patrols with Automatic External Defibrillators might be a

good idea when trying to improve mortality from out-of-hospital cardiac arrest. This may be a feasible strategy in Queretaro, where ambulance response times are 13 minutes on average (Chapter 4) and police officers are more often on-scene before any ambulance. Such experience has also been described in Netherlands (de Vries et al 2005) showing that competence was better when police first responders worked as teams and not as separate individuals. Weisfeldt and colleagues (2010) evaluated the impact of first response from the information from the Resuscitation Outcomes consortium in the United States, and they found that defibrillation by first responders was the main factor related to survival (OR 1.75). By extrapolating the information they calculated that 474 lives per year are saved because of defibrillation by first responders. Twenty-six percent of these first responders were police. That means that 123 lives were saved in one year by police defibrillating in the United States.

Stakeholders should seriously consider integrating the police and other strategic responders into the emergency medical response as first responders, particularly in cardiac arrest cases where CPR and defibrillation within the first minutes are precious.

Consumer Participation

As discussed in previous chapters, consumer participation is poor in Mexico, with the public confused about which emergency number to call (Chapter 3) and few victims receiving CPR by laypersons (2%). Eisenberg (2009) recommends that building up public expectations might also help generate the changes needed to increase survival from out-of-hospital cardiac arrest. High public awareness might be translated into an increased demand of high quality EMS services, including a unique, well functioning emergency phone number, first response units, advanced life support units and continuity of care within the emergency rooms of the private and public hospitals. Involvement of citizens in Emergency Committees has shown good outcomes as stated by O’Meara (2004) in Victoria, Australia.

One idea that Eisenberg (2009) suggests is to establish resuscitation committees within local communities that could publicise, month by month, the number of CPR attempts by the EMS and successful resuscitations, along with reports on response times. According to the finding of this study, in Queretaro the local Red Cross treated 147 out-of-hospital cardiac arrests (OHCA) in an 11 month period, and they treated 80% of the pre-hospital care situations within the city of nearly 1 million people. According to international benchmarks, the actual number of out-of-hospital cardiac arrests should be higher than that reported (Eisenberg 2009, Rea et al. 2004). One thousand cardiac arrests per year would be expected in a city of 1 million people. The lower than expected numbers of subjects in the study by Fraga and colleagues (2009) may be related to not only the capacity of the EMS system, but also the low expectations of the population that do not bother to make an emergency phone call when they find someone who has suffered a cardiac arrest.

Efforts should be made, not only to increase community awareness about CPR and first aid, but to enhance emergency telephone numbers, dispatcher training and to increase the community’s expectations of the EMS system.

Access to the System

Universal access should be the aim of all EMS systems. This access should be manifested through similar expectations of high quality and responsive care, measured through benchmarks such as appropriate response times, application of the correct procedures and positive outcomes from the

care given. However, caution needs to be applied to the use of some performance measures, such as response times, that will vary across the country depending on the EMS system that is in place. For example, while official ambulance services exist in the main cities, most rural communities rely on locally organised people who may not even have the capability to transport them. The high percentage of the population who live in rural communities is something to be considered when planning for improved access and equity in Mexican EMS systems.

Transfer of Care

Although the Regulation Centre for Medical Emergencies (CRUM, Chapter 3) was established as the national agency in charge of supervising the transfer of patients between hospitals and the appropriate reception of patients at the hospitals, it only exists in few states of the country. Nevertheless, it has the capacity to facilitate agreements between hospitals, hospital systems and emergency medical services to promote a smoother, less aggravating transfer of patients between hospitals. An established model has not been defined in Mexico. One reason is that while there are areas with strong physician participation within the EMS in other areas there is almost no physician involvement. Analysis of the existing models around the world should include the definition of an ideal “Mexican-Model” based on lessons learned in other countries. While in the North American and Australian systems (for example) there is a strong non-physician participation, in systems such as Germany and France the physicians work within the EMS system and continue the patient care inside the hospital (Dick 2003).

Standardized Patient Records

There is a national standard that recommends data that needs to be collected and recorded in patient records. Unfortunately, these recommended data are inadequate for research purposes. There is also a problem with documentation not being consistently and accurately completed. As mentioned previously, automated patient data transfer might be something to consider in terms of costs and benefits, such as the availability of information for research and quality improvement which in the longer-term may translate into saved lives. Revision of actual prehospital care records recommendations (Norma Oficial Mexicana 237) should include compliance with research standards such as the Utstein style for reporting prehospital care.

Public Information and Education

As explained earlier, the public expectation of the EMS system is low in Mexico. The misuse of the Emergency telephone numbers is high and the number of people knowing CPR is very low. Different strategies can be used to increase the number of people that actually perform CPR. In 2008, the American Heart Association published a statement supporting the use of “Hand-only CPR” for public information or mass education, with the aim of simplifying the CPR technique in a way that hardly will be forgotten by the population, and would be performed without reluctance (e.g. Reluctance to give mouth to mouth breathings) and could be delivered (the education) with different low cost strategies. (Sayre et al. 2008) This kind of strategy might be very useful in cities like Queretaro, where messages can be placed on posters in schools, bus stops, public places and shopping malls, while videos could be shown in food courts, schools, public places and banks just to mention some ideas. On the other hand, the idea for the EMS and other organisations (schools, churches, etc) to get involved in the mass training of CPR is quite common now in the United States and other countries, and might be a useful approach to increase public education. Examples are the CPR awareness week in the USA and Internet CPR Saturdays (or Sundays) (Eisenberg 2009).
Independent Revision and Evaluation

As Lilia (2004) recommends, all EMS should have in place Quality control strategies. Eisenberg on his book ‘Resuscitate!’ also suggests the idea of ‘framing’ the chain of survival, among other aspects with quality improvement (QI) strategies. According to Fraga and colleagues (2007) few EMS organisations measure quality, and most of them limit the measurements just to the measurement of variables such as response times or following up on patient satisfaction. Nevertheless, of those that do collect these data only 10 percent follow-up with any action to improve performance (Fraga et al. 2007). Several frameworks to measure Quality have been described (O’Meara 2005) around the world, most of them include outcomes from cardiac arrest (survival), severe trauma (survival) and also numeric details such as ambulance incident responses, proportion of services treated by paramedic level responders, response times (percentile 50th and 90th), level of patient satisfaction, expenditure, expenditure per person. According to O’Meara (2005) the Organisational Research Consultancy in the United Kingdom makes the following recommendations regarding response times:

- 95 percent of activation times should lie within 3 minutes;
- In Metropolitan services 50 percent of calls should receive response times within 7 minutes and 95 percent within 14 minutes;
- In Non-metropolitan services 50 percent of calls should receive response times within 8 minutes and 95 percent within 20 minutes

Nevertheless O’Meara (2005) reviews many authors and describes other performance dimensions that should also be observed and measured such as: effectiveness, appropriateness, safety, capability, continuity, accessibility & equity, acceptability, efficiency. Other success measures used by the South Australia Ambulance Service according to O’Meara are:

- Patients ready for ongoing treatment
- Timeliness
- Communication with patients
- Cost
- Revenue
- Preparedness for disasters
- Community awareness
- Staff satisfaction

In conclusion, O’Meara (2005) proposes a potential performance framework for ambulance services summarised in Table 1.

Halter, Marlow and colleagues in London (2006) use also the patient’s experiences of care as a measure of success that has even helped to compare the quality of care provided by two different kinds of prehospital care providers. Among the measurements they included from the views of the patients were:

- Overall care
- Response time
- Friendliness or courtesy
- Showing concert
- Listening
- Answering questions
- Examination quality
- Explaining condition
- Suitability of treatment or advice
- Thoroughness of assessment or examination
- Explaining what happens next
- Relevant information provided
- Patient comfortable with what happened
Research (as will be explained later) and Quality Management should be an integral part of the EMS in Mexico that not only measures quality indicators but should provide feedback to the overall system: EMTs and Paramedics, Medical Directors, Elected officials and of course the general public. Medical Directors should oversee this process and involve different official stakeholders.

Disaster Linkage

Although mandated by law, EMS is not actually considered in all disaster situations; for example the recent H1N1 epidemic in the city of Queretaro, where they were not considered during the response phase. According to Eisenberg (2009) EMS falls between different sectors such as health and public safety so no one holds complete responsibility over EMS or its integration for the overall response efforts. This is even more probable in Mexico where most pre-hospital care is provided by non-governmental organizations (lucrative or not) (Fraga et al 2007).

Laws should not only obligate the coordination of all emergency institutions in case of disasters, but also in day to day situations. There should be a public leadership for EMS and it should be empowered by laws. There is a big area of opportunity in this aspect in Queretaro and Mexico in general.

Mutual Help Agreements

Few mutual help agreements have been established in the country. The most representative ones are the ones surrounding the Medical Emergencies Regulation Center (CRUM) in Mexico City, where more than 20 hospitals from different social security sources (see chapter 2) signed agreements to see patients referred to them by the CRUM, not based on their right to that particular service (IMSS, ISSSTE, or any other as described in chapter 2) but according to the actual patient needs and the hospital resources as evaluated by the CRUM. These agreements warranty patients the best possible treatment, not based on the system they are affiliated too, but based on the patients needs and the resources available at the different hospitals. This model should be replicated in other states. The health secretariat should take a strong leadership role to develop this kind of agreements in the best interest of the patients.

Other possible agreements are those related to private hospitals. One possible benefit in Queretaro is that while there is no possibility of having primary angioplasty in the public sector, at least two private hospitals in the city have fully equipped cardiology services ready to provide this treatment. These efforts are important in terms of equality and accessibility for the different services that at the end point modify the outcomes of the patients treated by the EMS.

Research

Research has been established as a strategic part of EMS development in documents such as Lilia’s (2004) and the EMS Agenda for the Future (Delbridge, 2009). Nevertheless, higher emphasis has

been placed on this point by various authors worldwide such as, Sayre (2001) in the document EMS Research Agenda for the Future and Tippet (2003) in a similar document in Australia. Unfortunately the volume of EMS related research production is still very low in Mexico. The recommendations made by Sayre (2001) were that EMS systems should undertake the following steps:

- Develop Researchers
- Facilitate Collaboration
- Establishing a reliable funding stream
- Establish alternative funding sources
- Recognise the need for EMS research
- View research as necessary for the improvement of patient care
- Create reliable information sources
- Enhance ethical approaches to research

While some of these recommendations are not currently possible in Mexico, universities and research centres should consider developing EMS related research programs that promote the generation of postgraduate studies focused on EMS research and finding funding sources for EMS research. There is a great need not only to replicate what is happening in other more developed EMS systems around the world, but to generate local information that would enable the design of the best possible Mexican EMS.

Step by Step Interventions

In emerging economies, not all the aspects of the EMS system can be enhanced at the same time. VanRooyen (1999) suggests that seven steps should be approached during the early phases, and then the other eight. These steps are explained in Table 2. Manpower, Training, Communications, Transportation, Facilities, Access to care and Coordinated patient record-keeping might become some of the initial aspects to be considered when leading a pre-hospital care program that wants to be enhanced. The rest can be considered during later phases of the intervention. Nevertheless I propose that interventions should be based not only on a planned and structured idea, but also be opportunistic in response to the social, economical and political environment. Stakeholders should keep these ideas at hand and when opportunities arise, implement, communicate or evaluate these aspects in order to generate some kind of improvement with enough flexibility to take advantage of all the possible opportunities; in other words, it is not a ‘lock-step’ approach.

<table>
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<tr>
<th>Initial Essential EMS components</th>
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<tr>
<td>Manpower</td>
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<td>Training</td>
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<td>Communications</td>
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<td>Transportation</td>
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<td>Facilities</td>
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<td>Access to care</td>
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<td>Coordinate Patient Recordkeeping</td>
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<th>EMS Components for Gradual Implementation</th>
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<td>Critical Care Units</td>
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<td>Public Safety Agencies</td>
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<td>Consumer Participation</td>
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<td>Patient Transfer</td>
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<td>Public Information and Education</td>
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<td>Review and evaluation</td>
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<td>Disaster plan</td>
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Table 2. - Components of the EMS systems (VanRooyen 1999)

In Canada the Emergency Medical Services Chiefs of Canada (2006) has established six key strategic directions that will enable a positive and controlled movement toward an established vision for the EMS system which are:

- Clear Core Identity
- Stable Funding
- Systematic Improvement
- Personnel Development
- Leadership Support
- Mobilized Health care

**Eisenberg’s 25 steps model**

Based on the content of the previous chapters, some recommendations have already been made, based on Lilja’s framework (2004). Nevertheless the central research aspect for this thesis was the evaluation of Out-of-Hospital cardiac arrest (OHCA) in one Mexican City with the belief that the evaluation of OHCA is the best model to evaluate outcomes from the EMS activity in one community. With the same belief that any intervention focused on improving OHCA survival will finally be translated into improvements that will affect other aspects of the EMS system, improving also outcomes such as survival from severe trauma. Dr. Mickey Eisenberg (2009) shares this viewpoint and proposes a 25 step plan to increase survival from cardiac arrest at the local, regional and national level in the United States.

I will refer to this 25 step plan as a possible framework for activity related to the enhancement of EMS

in Queretaro, where the main research of this document was performed. Table 3 summarises Eisenberg’s steps.

<table>
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<tr>
<th>Immediate Steps</th>
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<tr>
<td>Establish Rapid Dispatch</td>
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<td>Begin an aggressive program of dispatcher-assisted telephone CPR</td>
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<td>Develop a community cardiac arrest registry</td>
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<tr>
<td>Promote Public Access Defibrillation</td>
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<td>Voice Record for all attempted Resuscitations</td>
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<tr>
<th>Steps involved in local action plans</th>
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<td>Political Leadership</td>
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<td>Administrative Leadership</td>
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<td>Medical Leadership</td>
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<tr>
<td>Establish a tiered-response system</td>
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<tr>
<td>Create a comprehensive cardiac arrest registry</td>
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<tr>
<td>Provide continuous quality improvement</td>
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<tr>
<td>Improve skills among paramedics, EMTs and dispatchers</td>
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<tr>
<td>Institute Hypothermia therapy</td>
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<tr>
<td>Encourage citizen participation</td>
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<td>Establish Programs in prevention</td>
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<th>Steps involved in National action plans</th>
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<tr>
<td>Political Leadership</td>
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<tr>
<td>Create a national lead agency for pre-hospital emergency care</td>
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<tr>
<td>Establish National Performance Standards</td>
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<tr>
<td>Establish a new entity the National Institutes of Health</td>
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<tr>
<td>Revise human subjects regulations and a national process for their periodic review and approval</td>
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<tr>
<td>Revise HIPAA laws to enable EMS research</td>
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<tr>
<td>Redefine Cardiac Arrest as a reportable disease</td>
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<tr>
<td>Establish Guidelines for a compassionate withholding of resuscitation</td>
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<tr>
<td>Create comprehensive EMS research centers</td>
</tr>
<tr>
<td>Provide tax incentives for CPR training and purchase of AEDs</td>
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Table 3.- Eisenberg’s 25 steps for improving OHCA (2009).

Immediate Steps

- **Establish Rapid Dispatch**: Refers to the objective of dispatching the closest EMS response vehicle (or police car) to the patients, seconds after the call is received. This requires commitment from the dispatch centre leaders and the measurement of performance. On the other hand it requires the training of Call receivers and dispatchers to react with specific call clues. It also requires continuous education.

- **Begin an aggressive program of dispatcher-assisted telephone CPR:** For this to happen, again, it should be led by committed people, calls recorded and monitored, call receivers/dispatchers should be trained and feedback provided. It should include the recognition of agonal respirations (as they are related with good prognosis in OHCA). It should also consider continuous education.

- **Develop a community cardiac arrest registry:** This registry should include, electronic records from defibrillators and AEDs apart from patient related data (Utstein style is a good starting point), the effort can be done in conjunction with the data collection needed for the dispatch centre.

- **Promote Public Access Defibrillation:** Public access defibrillation programs have proved to be very successful in increasing survival from cardiac arrest. Places where AEDs can be placed are: airports, health clubs, jails, community centres, senior centres, shopping malls, and office buildings, among others. AEDs should be registered with the local dispatch centre in order to promote their use if there is a need in the close vicinity. Computer aided dispatch centres can have this information available while attending the call.

- **Voice Record All Attempted Resuscitations:** It will be useful in many ways, one of them is by calling the attention of the ambulance personnel that someone will be listening to the records and analyse the performance of the ambulance crews on OHCA. It also provides raw data with which EMTs and paramedics can receive feedback and with which research can be performed.

- **Local Action Plan**

  - **Political leadership (at the local and National Level):** as Eisenberg stated “Political leadership is the only route to unity of command and accountability”. He suggests that there should be only one agency running the EMS which is finally a political decision. At the national level, political leadership can be gained through associations with a vast lobbying capacity such as the National Association of EMS Physicians (NAEMSP) in the United States. Few organisations currently have that capacity in Mexico, but is a legitimate goal for the existing groups to build an effective lobbying capacity to promote the legislation of life saving interventions such as those mentioned throughout this thesis.

  - **Administrative leadership:** administrative leadership is needed to guarantee that there are enough resources. This leader must be in part responsible for creating a culture of excellence and should maintain close communication with the Medical Director.

  - **Medical leadership:** according to Eisenberg, the medical director must state and promote high expectations and all EMTs should be accountable to the medical director. Eisenberg suggests that ideally a Medical Director should also have an academic appointment. This is justified by the physician’s commitment with the learning process, knowledge about epidemiology and access to a diverse body of experts through their affiliated academic institution.

  - **Establish a tiered response system:** Eisenberg says, in his book, that tiered systems might become very useful with EMTs attending first and supported by paramedics. He suggests that this first response might even be policemen. This might be one way to move in cities like Queretaro, where the security corps have good financing, enough vehicles and some sort of

Quality Improvement program.

• **Create a comprehensive cardiac arrest registry:** Eisenberg says that “A cardiac arrest registry is a means of taking the entire EMS system's temperature - if cardiac arrest is well managed it is more than likely that all other conditions will be well managed. In this sense, cardiac arrest serves as a surrogate for the whole system.” Eisenberg refers to this registry as a more comprehensive version of the previous one, with data not only from EMT's and Paramedic's but from the dispatch centres, AEDs, voice recordings, and hospitals. This registry should be considered a core function and not be threatened by budget cuts and political shifts. Small communities can work together in building such a registry within their combined budgets.

• **Provide Continuous Quality Improvement:** with the support of the Cardiac arrest registry, a Quality Improvement program can be put into place. Some indicators Eisenberg suggests that can be followed up (among others) are: Overall rate of survival from witnessed VF, determinants of survival (response times, advanced life support, etc), CPR instructions offered, recognition of agonal respirations, time to begin telephone CPR instructions, rapid dispatch, time to defibrillation, CPR density, use of medications, number of intubation attempts, IV lines, central IV lines, Intraosseous, hypothermia use.

• **Improve Skills among Paramedics, EMTs, and Dispatchers:** Eisenberg mentions that continuous education is a useful tool, but that actual performance is the best tool to improve skills. There is also evidence collected by Gold and et al. (2009) where the paramedic that actually performed the procedures provided a better possibility for survival if he/she had more years of experience. Eisenberg suggests that paramedics should be completely dedicated to this job and obviously gaining the needed experience to perform favourably every time they do it. EMTs and Emergency dispatchers need to be trained and understand what high quality CPR and defibrillation are and need to understand the importance of nurturing these efforts. Looking at the actual system in Queretaro, it might be an interesting idea to turn police who have short response times, a large budget and continuous education already in place into basic EMTs or the equivalent. It could be feasible to equip patrols with basic first aid equipment and AEDs and then turn the actual EMT crewed ambulances into Advanced Life Support ambulances crewed with paramedics (response times around 13 minutes). Automatically this action would produce ideal response times without a significant budgetary change.

• **Institute Hypothermia Therapy:** when a patient is resuscitated after VF and is still in coma, the standard for care is to maintain the body's temperature for approximately 24 hours. This hypothermia can begin from pre-hospital care by instilling 2 litres of crystalloid solutions at 4º C. Studies are currently underway, however there will not be a quick answer with sufficient evidence about this procedure available for some time. Once we have advanced life support in Mexico, it might become a need to look into this concept to see if enough evidence has been gathered and the technology available to offer patients this kind of care.

• **Encourage Citizen Participation:** it is within the community where OHCA happens, and it might also be important to consider having members of the community become stakeholders within the EMS system. Some strategies may be: including community members as part of the boards of EMS systems, wide-scale training in CPR and when to call 911 (it can even be done during half time of sporting events), and promote this kind of information in schools, churches, or even on the back of drivers licences. Now with Hands-only CPR recommendations (Sayre et

al 2008) it is even easier to promote at least some kind of action by citizens.

- **Establish Programs in Prevention**: In Seattle, Washington EMS has contact with 8% the population every year, while in Queretaro the local Red Cross treats around 20% (23,000 patient contacts between its small hospital and the ambulance services). Cardiac arrest is the final outcome from diseases like obesity, diabetes and hypertension. EMS staff should always promote prevention, by remembering patients with such risk factors to do something about them, before they become OHCA arrest patients. EMTs and Paramedics should be encouraged to identify patients with high blood sugar levels or high blood pressure, for whatever reason they see them, and promote a healthy life style in order to prevent an outcome such as Myocardial Infarction or even cardiac arrest. The same can be done in Mexico, since prevention is much cheaper than response in relation to cardiac arrest. In economies such as the Mexican one, preventions should be privileged.

**National Action Plan**

- **Create a National Lead Agency for Pre-hospital Emergency Care**: it would be ideal to have a National agency overseeing factors such as: communication equipment, coordination between EMS and hospitals, uniform training and supervision, accurate data acquisition, funding mechanisms, readiness for disasters and evidence based decision making. Ideally this agency should be part of the health sector of the government, but should consider that the EMS system navigates in between many sectors (health care, public health, public safety). In Mexico, the National Center for Trauma Prevention (CONAPRA) has more or less led these efforts, but because of its nature has always focused on the Trauma aspects of EMS rather than the medical aspects. On the other hand the Mexican Institutes of Health (Cardiology, Medical Sciences, and Public Health) has not looked into the EMS and the public culture as part of their every-day research activities which might be also an area of opportunity to link EMS research to one of these high academic and research activity institutions.

- **Establish National Performance Standards**: standards should be promoted and financed through a national EMS system. In relation to cardiac arrest Eisenberg proposes the following standards for urban EMS systems, that can become a model in high expectation communities in Mexico: Bystander CPR in more than 50% of cardiac arrests, telephone CPR in more than 25% of all cardiac arrests, Less than five minutes between pickup of the call to the emergency phone number and the arrival of EMTs at the patient’s side more than 90% of the time, less than six minutes between pickup of the call to the emergency phone number and the first defibrillator shock more than 90% of the time, less than ten minutes between pickup of the call to the emergency phone number and the arrival of paramedics at the patient’s side 90 percent of the time, use of voice and heart rhythm recordings in all resuscitations, medical director’s review and critique of all resuscitations, discharge of patients with VF from the hospital more than 25 percent of the time. It looks to be a difficult goal to achieve, but it is proven that it can be done, and more important is that it can be done in Mexico by just placing AEDs in patrol vehicles and training police as EMTs while increasing the capacity of the actual EMS to become Advanced Life Support (ALS) capable.

- **Revise Human Subjects Regulations and Devise a National Process for Their Periodic Review and Approval**: in the United States, human research has become such a big activity, that strong regulations are in place regarding patient consent and patients privacy in such a way that it is hard for EMS doing research on cardiac arrest (it is hard to get a signed consent

from an arrested patient or his/her family). In Mexico, there is not such a restrictive research environment, nevertheless ethical issues will arise and the need to consider such research as in cardiac arrest should be addressed before these types of regulations are promulgated.

- **Revise HIPAA Laws to Enable EMS Research:** the Health Insurance Portability and Accountability act in the United States prevents some EMS to get hospital information from patients in order to measure outcomes. Seattle, Washington has overcome this problem by arguing that the information is going to be used only for Quality Improvement purposes. Although in Mexico it is not an issue yet (just like with the previous point) portability might be an alternative to solve some of the differences that arise from the different health care systems in Mexico (see chapter 2) and regulations that come from this process might also affect how information is gathered and communicated. EMS research and QI should be considered when this happens.

- **Redefine Cardiac Arrest as a Reportable disease:** In 2008, the American Heart Association issued a scientific statement describing the essential features for designating cardiac arrest a reportable disease (Graham 2008). As Eisenberg mentions, the fact of such a diverse success with cardiac arrest programs around the United States, and might be the same with Mexico, justifies making this “Dirty Little Secret” a reportable studied disease. It might be possible that the same action in Mexico, not only helps establishing a basis for evaluation EMS around the country, but to raise the attention of major stakeholders at the national level.

- **Establish Guidelines for Compassionate Withholding of Resuscitation:** Eisenberg and others have promoted this process at the national level in the United States; nevertheless it might be an option at the local level when there is no standard or policy defined at the national level. Nevertheless, once EMS has evolved to a sufficient level, it might become a necessity to build up a basis for the EMS personnel to decide when it has been enough, and have a clear basis on where to withhold resuscitation.

- **Create comprehensive EMS Research Centres:** as mentioned in chapter 3, few publications have emerged around EMS in Mexico, but most of them are working around Universities that might in the future become more specialised EMS research centres. Highly specialised research centres can auspice difficult research or establish high impact research lines that can affect the future of EMS in Mexico.

- **Provide Tax Incentives for CPR training and Purchase of AED:** as Eisenberg mentions, a tax incentive (e.g. Making CPR courses deductible) or tax credit against the acquisition of AEDs might be a nice incentive. In Mexico, property taxes are administered at the local level while the rest of the taxes are administered at the federal level, which means that incentives like this one should born at the national level.

As Eisenberg summarises these concepts, he suggests to change the traditional chain of survival to a five links chain, adding “Early-Post resuscitative care” as the fifth link (characterised by hypothermia), all surrounded by a framework made up of four concepts: Culture of Excellence, Administrative and Medical Leadership, Training and Continuing Education and Medical Quality Improvement (2009). This can be a model of excellence that might be considered in the design of the actual EMS systems in Mexico and particularly in Queretaro.

From Theory to Practice

In February of 2009 I received the offer to become the board president of the local Red Cross. Although it is an honorary title, it gives me the opportunity to implement some changes based on the experience gained since 2003 when I began this doctoral program. What I knew was that in general the EMS system was not good enough to save any life after out-of-hospital cardiac arrest, based on the research published this year (Fraga et al. 2009 and chapter 4), that most providers were volunteers with few years of experience and limited training (chapter 3). We received an organisation with some financial problems. The Red Cross in Queretaro was financed mainly with donations and some revenue for some services (not including the ambulance service which consumes around 30% of the expenditure). Most of the personnel were not motivated and there was no clear view of where the organisation was heading. The overall community did not appreciate the institution until they were treated. Fortunately more than 80% of the people treated by the Red Cross had a good opinion about the service. Nevertheless it provides an important number of pre-hospital care services (around 10,000 per year) and around 13,000 medical attentions in its small hospital. The appointment gives me also, some political authority and exposure to media.

The organisation had no director, and it had six different divisions with one coordinator each who reported directly to the board. These divisions were: Pre-hospital Care Services, Hospital, Administration, Juvenile coordination, Ladies and training division. The areas were completely fragmented with few interactions among people from different areas, not taking advantage of the multidisciplinary opportunities offered solely by the profiles of the people in the different areas. We created three new areas which are: fundraising, quality improvement and a general direction that oversees the operations on a day to day basis.

After this appreciation we decided that we needed to raise the "self esteem" of the people at the institution, and to help people appreciate the huge capacity they have as a team focusing their efforts toward one goal. With that view we established the goal to diminish pre-hospital cardiac arrest mortality in the city within one year beginning in July 2009. The plan includes 42 steps based on the first 15 recommendations made by Eisenberg. Every area coordinator is required to report advancements in each of his/her tasks on a monthly basis, and we is assessing the results of all these interventions using a permanent Out-of-hospital cardiac arrest registry. The research is being supported by a local University and some of the investment needed is coming directly from fund raising while we pursue research grants. All these actions have taken place despite the fact that the local Red Cross is currently not part of the political/public services structure of the municipality, although, it can influence the decisions of the different stakeholders in the community.

Table 4 shows the forty-two steps established as part of our strategy to diminish out-of-hospital cardiac arrest at the local level. We not only hope that this will help change the outcomes of OHCA arrest patients, but also increase the expectations among the community and the pre-hospital care providers themselves. With this strategy the outcome should allow stakeholders to feel that they can really make a difference.

Although the local Red Cross branch is an important player in the local EMS system, the rest of the components such as the Emergency Number (066) response centre are not managed by the Red Cross. Moreover it is not even managed by a health authority; rather it is part of the National Security System and so in that sense the local Red Cross is far from changing the way that number works. We can only become a local influence for the social demand for a better service that forces the changes needed. It is in this sense that this plan is implemented, with a clear view on where we can directly

make changes and where we are only an influence towards that change.

Based on the data shown by Fraga’s research (2009):

• Low rate of public CPR

• Slow average response times (using means)

• Low percentage of procedures performed

We decided to use the Red Cross’ influence to change part of this reality and continue to measure OHCA indicators to measure the effect of such interventions by:

• Establishing permanent contact with the municipal public security direction: the local public security direction is in charge of managing the official emergency number (066); physically the Red Cross number (065) is in the same place but not sharing the infrastructure. Nevertheless, quality indicators are not measured, and some aspects of quality management are hard to facilitate. For example; recordings of the actual cardiac arrest calls have been denied, with the argument that all phone calls received are considered security related information (note: the 066 number is a Public Security number) so they, legally deny that information. On the other hand, the local Red Cross provides 70% of the actual emergency medical calls they respond to, so establishing good relations can help them in providing a better service and helps us finding ways to get the information we need to increase the quality of our service.

• Measuring time between the call received and the ambulance dispatch: it is an indicator that is being measured already. Nevertheless they are still using the average times as the most important indicator and not the median and the 95th percentile. During the next months we will be training supervisors at the dispatch centre to measure and report these times.

• Creating a high quality committee: this committee will include major stakeholders at the local Red Cross and also major stakeholders within the local public safety system. We want to send a strong message of openness hoping that others will follow, and will share strategies and goals.

• Testing the response on 066 and 065 numbers: we will be doing drills to measure and record the response from both emergency numbers. We are also discussing the possibility to use simulation within the community to test our own system.

• Designing an Emergency Medical Dispatchers training course: we have already trained the Red Cross's dispatchers; nevertheless none of the dispatchers (065 and 066) has been trained on Emergency Medical Dispatch. We are designing a course that includes telephone assisted CPR.

• We have already begun to ask for the recordings from all the OHCA cases from the 066 number and we are budgeting for equipment to record the calls of the 065 (Red Cross) number. Nevertheless the public security secretariat officers are neglecting these recordings, based on a law that establishes those recordings as reserved government information that cannot be shared. Government officials are changing soon, and if they still neglect the information after the change, we might try to negotiate that instead of showing the recordings,
they analyse them and report the data found on a form that we provide.

• Documenting and analysing all the OHCA cases. We have been piloting this registry for the last two months and we are beginning to provide feedback to the personnel and during the next weeks we might begin to provide feedback to the entire community.

• We have just equipped the ambulances with defibrillators that are able to generate reports and we are asking all of our EMTs to print these reports and turn them in along with the registry form.

• Revising all the cardiac arrest information every two weeks and providing some feedback to our personnel. It doesn’t take too much time if it is done routinely and it helps in correcting mistakes quickly while the personnel still can recall the event.

• In October we will begin publishing each month’s indicators on our website, in order to provide stakeholders and the general public with performance indicators of Out-of-Hospital Cardiac Arrests. We will be publishing survival rates, response times, and the number of patients receiving CPR before the ambulance arrives, the number of cases in which the police arrive before the ambulance and if the policemen were giving CPR by the time the ambulance came.

• Inviting other local organisations to measure their own indicators. We are offering use of our system.

• Using the Red Cross to promote through the Media. The Red Cross participates in many public events, and we have had some media exposure. We have agreed that all of the personnel that go to such events or whom are interviewed by the media should send the message about Public Access defibrillation and CPR training. These efforts will also be done with all the public servers at the local and state level.

• Equipping ambulance teams with digital recorders and asking them to record their events. That will not only allow us to have more accurate data from the arrests treated, but also will give us a strong tool to provide with constructive feedback to the different crews treating the arrests.

• This year we will have a new Governor and a new Mayor. It is at the beginning of their administrations when they decide which flags they will be using, so we are also “selling the idea” of becoming the first “cardiac-safe” city in Mexico. If they like the idea, the Red Cross and the EMS in general might get the political support needed to make some real profound changes.

• According to Eisenberg (2009) and other authors, tiered response systems might be beneficial in diminishing out of hospital cardiac arrest mortality. Nevertheless the investment needed to increase the capacity of the Local Red Cross is very high and being a Non-profit organisation with low governmental financial support, it might be considered a huge task. Nevertheless the local police have good resources including a large number of emergency vehicles and quick response times. Training all the police corps in CPR/ First Aid and providing them with Automatic External Defibrillators might be a way to achieve in the short term better “collapse to CPR and collapse to defibrillation intervals”. The Red Cross might then, become the second tier and provide for more advanced care. Training and equipping can be provided without actually increasing the operations budget significantly.

- Increasing liaison with the public and private hospitals in the city. Our hope is to increase academic exchanges in order to integrate more responses, increase the continuity of care for the patients and also facilitate the follow up of all the EMS treated patients, particularly those treated from Out-of-Hospital cardiac arrest.

- Developing performance indicators in all of the Red Cross areas (not just pre-hospital care) in order to develop a quality improvement culture and increase the expectations of the organisation. We want to develop a culture of excellence.

- Training more personnel. We have trained eight American Heart Association BLS instructors and hired one ACLS instructor to provide all of our structure with internationally recognised resuscitation courses. The plan is to have all physicians and EMS personnel certified in ACLS within one year. This particular point is becoming also a research project for one medical student at a local University. We will measure OHCA outcomes, before and after implementing ACLS.

- Providing our EMTs with a workshop on airway management, although the role of advance airway management is becoming debatable in OHCA, in other situations such as Trauma is still a recommendation. 50% of what is treated in Queretaro is related to Trauma and the use of airway management devices is low in this Red Cross branch, the training might provide with information and confidence for our EMTs to use these devices more often.

- Providing Hypothermia Therapy to physicians working at the emergency hospitals that we take patients to. This effort might increase not only the use of this therapeutic strategy, but also increase the moral authority of the Red Cross among the medical community.
# Advancement Indicators: Project for diminishing OHCA in Queretaro

<table>
<thead>
<tr>
<th>Objective</th>
<th>Responsible</th>
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<tbody>
<tr>
<td>Establishment of Rapid Dispatch</td>
<td>General Director/Prehospital Care</td>
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<tr>
<td>Measure time between call received and ambulance dispatch</td>
<td>Prehospital Care</td>
</tr>
<tr>
<td>Creation of a Quality Committee</td>
<td>Board President</td>
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<tr>
<td>Assess response on 066 and 065 numbers</td>
<td>Secretary Quality Committee</td>
</tr>
<tr>
<td>Design of an Emergency Medical Dispatchers training course</td>
<td>Training/ Juan Manuel Fraga</td>
</tr>
<tr>
<td>Invite Dispatchers from 066 and 065 numbers</td>
<td>Prehospital Care</td>
</tr>
<tr>
<td>Teach the course</td>
<td>Training/ Juan Manuel Fraga</td>
</tr>
<tr>
<td>Install equipment to record all emergency phone calls</td>
<td>Prehospital Care</td>
</tr>
<tr>
<td>Ask for recordings from all OHCA cases from the 066 number</td>
<td>Secretary Quality Committee/Prehospital Care</td>
</tr>
<tr>
<td>Appropriate documentation for OHCA cases</td>
<td>Prehospital Care</td>
</tr>
<tr>
<td>Print report given by lifepak 12 equipment and annex it to the report as long as with the ambulance</td>
<td>Prehospital Care Personnel</td>
</tr>
<tr>
<td>Revise information from the OHCA registry every two weeks</td>
<td>Secretary Quality Committee</td>
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<tr>
<td>Monthly feedback to personnel, board, and general public with OHCA statistics</td>
<td>Secretary Quality Committee</td>
</tr>
<tr>
<td>Invitation to other organizations to participate on the registry</td>
<td>General Director/Prehospital Care</td>
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<tr>
<td>Foster in all public training activities the acquisition of AEDs</td>
<td>Training</td>
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<tr>
<td>Promote the use of AEDs on all events and opportunities that are presented</td>
<td>All personnel</td>
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<tr>
<td>Fosters the acquisition of AEDs on high risk patients</td>
<td>Prehospital Care and Medical Services Personnel</td>
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<tr>
<td>Promote Public Access Defibrillation programs with public servers</td>
<td>General Director/Board Members</td>
</tr>
<tr>
<td>Acquire digital recorders and place them with defibrillators on ambulances</td>
<td>General Director/Prehospital Care</td>
</tr>
<tr>
<td>Record all events when they happen</td>
<td>Prehospital Care Personnel</td>
</tr>
<tr>
<td>Review of the voice records</td>
<td>Quality Committee</td>
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<tr>
<td>“Sell” the idea of making Queretaro the first “Cardiac Safe” city in Mexico</td>
<td>Board Members/General Director</td>
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<tr>
<td>Followship on this program and quality indicators</td>
<td>General Director/All division coordinators</td>
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<tr>
<td>Medical Leadership</td>
<td>General Director</td>
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<tr>
<td>Establish a Tiered Response Program</td>
<td>Board Members/General Director/Prehospital Care</td>
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<tr>
<td>Prepare a course for policemen on first aid, CPR and AED use</td>
<td>Training</td>
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<tr>
<td>Maintain closeness with the public security direction</td>
<td>Board Members/General Director/Prehospital Care</td>
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<tr>
<td>Create a comprehensive Cardiac Arrest Registry (Long Term)</td>
<td>General Director</td>
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<tr>
<td>Increase liaison with other health institutions</td>
<td>General Director</td>
</tr>
<tr>
<td>Establish performance indicators in all the redcross areas</td>
<td>Quality Committee</td>
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<tr>
<td>Monty data revision about performance indicators</td>
<td>Secretary Quality Committee</td>
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<tr>
<td>Personnel feedback with performance indicators</td>
<td>Secretary Quality Committee/Juvenile division</td>
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<tr>
<td>Provide for an 24 people AHA BLS course on a monthly basis</td>
<td>Training</td>
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<tr>
<td>Provide a weekly AHA ACLS course for 6 people</td>
<td>Training</td>
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<tr>
<td>Design and implement an airway management course</td>
<td>Training</td>
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<tr>
<td>Invite other organizations to participate in these courses</td>
<td>Training</td>
</tr>
<tr>
<td>Introduce Hypothermia Therapy</td>
<td>General Director</td>
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<tr>
<td>Increase liaison with other health institutions</td>
<td>Training</td>
</tr>
<tr>
<td>Organize training for hospital personnel (Red Cross and other hospitals)</td>
<td>General Director</td>
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<tr>
<td>Promote citizen participation</td>
<td>Board</td>
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<tr>
<td>Implement Hands Only CPR Programs</td>
<td>Training/Juvenile division</td>
</tr>
<tr>
<td>Publish local statistics on OHCA on our page and also on media</td>
<td>Quality Committee</td>
</tr>
<tr>
<td>Establish Prevention Programs</td>
<td>Medical Services</td>
</tr>
<tr>
<td>Make booklets with information on hypertension, diabetes, obesity and hyperlipidemia</td>
<td>Prehospital Care and Medical Services Personnel</td>
</tr>
<tr>
<td>Distribute booklets among patients with risk factors</td>
<td>Prehospital Care and Medical Services Personnel</td>
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</table>

Table 4.- Steps of our strategic plan to diminish out-of-hospital cardiac arrest mortality in Queretaro, from the local branch of the Red Cross perspective.

• According to Lilia (2004), Delbridge (2009) and Eisenberg (2009) community participation is critical, in that sense we are planning or are already providing to:
  ◦ Include citizens in the Quality Committee
  ◦ Train a more extensive number of the public sector. We designed a short, Hand-only CPR course for free training in schools and other organisations in order to be able to train thousands of people with this simplified technique instead of taking more time to train less people with the traditional CPR courses. People willing to take more training will be provided with a low cost, more complete course.
  ◦ Publish information on our website and other public media. We will also collaborate with other organisations such as Universities promoting CPR and rapid response to OHCA.
  ◦ Design booklets with prevention information to give to patients with risk factors identified in our ambulances or our hospital.

I hope that all these efforts can be translated into increasing the number of people trained in CPR in the public, increasing the amount of actual procedures performed by the EMTs and Police Officers and finally increasing the community expectations towards pre-hospital care in order to generate some Political leadership that can help make the profound changes needed to make our system a more efficient, accessible system for the overall community.

The journey to where we are now, began many years ago. Although I begun this doctorate in 2003, it was since 1993, when I became an Emergency Medical Technician and perceived the great need for development in this health area in Mexico. Today, September 2009, half the Mexicans that die, die outside of hospitals, most of them at home. The first contact they might have with the health care system are the ambulances which are in a forgotten area between the public safety and health care system in Mexico. It is within this area that I decided to do this research and that decided to continue to focus my professional life efforts. In 2003 I thought doing a research in the area wouldn't be too difficult, but by 2006 when I was gathering all the information I thought I wouldn't see finished this thesis, not even to have a published article in an indexed magazine. I knew that they were treating cardiac arrests in the ambulances at the local Red Cross, but none of the EMTs wanted to fill out the forms appropriately. I was tempted to change the topic of my research, but I received a phone call from my supervisor Dr. Peter O’Meara, and another colleague from England, they made me see that I was on the right track, that a lot of researchers went through the same obstacles. It was like magic, less than a week after that call I began receiving the forms and I was able to do, at least part of what I wanted to do with the data.

Since 2007 I began speaking about the results I found in different forums and I began to try to publish my article (which was another adventure itself). I sent it to one of the few indexed journals in Mexico (Gaceta Médica de México) and they revised it. It was rejected, one of the revisers wrote that it was a very bad article, that it should be published as an alarmist note in a newspaper and that the only thing it reflected was the bad training EMTs had in Queretaro. He/she was supposed to be an “expert” on the topic in Mexico. It was rejected, also, from the Resuscitation Journal, but the revisers comments were very illuminating and helped improve a lot of the way the article was written. Finally it was accepted in the Prehospital and Disaster Medicine Journal and after few editions based on very
constructive revisers’ comments, it was published early this year. Last month I received an email from Germany asking me for a copy of the article. Apparently they will be using it as part of the revisions for the international liaison on resuscitation that will be happening next year.

Maybe because the information generated, maybe because a political issue, I still don’t know, the fact is that in February this year they asked me to chair the board of the local Red Cross, the same place where I couldn’t convince the people to fill out the forms. They will be a couple of years in which I will have the opportunity to try to change a little bit of our reality and to enhance our “delayed” EMS system. It might also become an opportunity to trace a route for others to follow my steps and walk even further. I am really optimistic of where this doctorate is taking me.

Final Words

On May 16, 2009 I was having lunch during a pool party at a friend’s house. My wife and my two boys were there, along with a number of close friends and their children. I saw my youngest boy approaching the pool without his flotation device but saw my wife nearby. After a couple of minutes I heard my wife shouting for me with an unconscious, wet boy in her arms. I ran towards her and received the unconscious boy. I asked a friend to call an ambulance (praying for an ambulance with a defibrillator to get there), and checked for breathing and a pulse but finding that there were none. I began CPR and after one cycle another friend (a CPR certified cardiologist) began helping me. By the second time I gave rescue breathings to the boy I realised it was not Joaquín, my son, but Noah, the son of my good friend Heath. We continued CPR for about two minutes after which Noah began crying and moving a little bit. Heath and his wife hugged me and my friend Enrique and after that day many things have come to my mind. Noah is the first OHCA documented survivor in the city of Queretaro and it was not because I knew how to defibrillate, apply medications, manage an airway or any other advanced skill. The fact is I really feel fortunate, not because I am a Physician with a Paramedic background in Mexico, but because I know CPR. Because of that basic skill; and that I was able to provide it during the first minutes after the collapse of my good friend’s son, he is alive and healthy today.

I hope that everything I have learned during the last six years can be used somehow in my country to make many other people feel the way I feel since that near tragic day.

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To my teacher colleagues, specially Heath Sparrow, Noah’s father, and the person who revised my English writing in this text. Arturo and Paco for supporting each other to make some real advances with our thesis. To my medical colleagues, thank you for being a model for me.

Julio, Quique, Fernando, Anette and all the people who share my passion for prehospital care in Mexico, your work and your example has always been my inspiration. I really want to be a little like you in the future.

Finally to my supervisor, Dr. Peter O’Meara. With one phone call, he was able to motivate me to go on with what we considered an ambitious project that it is now a reality. Thank you for believing in me.

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