

TRAUMA IN SANTA CRUZ COUNTY - 2006

Executive Summary of Santa Cruz EMS CQI Meeting - Annual Trauma Review
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On June 4, 2007 Santa Cruz County Emergency Medical Services (EMS) hosted the annual Trauma Review as a special Continuous Quality Improvement (CQI) Meeting. This meeting was attended by the regular Santa Cruz Prehospital Advisory Committee members, representatives from our two local hospitals, the three Santa Clara County Trauma Centers, both air ambulance services, the local ground ambulance provider, representatives from the local fire-based paramedics, and representatives from Santa Cruz EMS, Santa Clara EMS, San Mateo EMS, and San Benito EMS.

Overview

For the calendar year 2006, the prehospital system (EMS) of Santa Cruz County responded to 9,737 individuals. Patients were divided broadly into two categories – ‘medical’ and ‘trauma’. The ‘medical’ patients included 6,869 who had chief complaints such as cardiac failure, respiratory distress, seizures, etc. The 2,868 patients categorized as ‘trauma’ included everything from minor lacerations and fractures up to major multiple trauma from motor vehicle crashes, assaults, stabbings, gunshot wounds, falls, etc.

The focus of our Trauma Review was the 2,868 trauma patients and a detailed analysis of 281 trauma victims with full hospital outcome data who had been transported directly from the field to Trauma Centers in Santa Clara County. We also analyzed 79 trauma victims with full hospital outcome data who were admitted to Dominican Hospital.

At the Trauma Review we reviewed the Multiple Casualty Incident of 1/29/07. Clinical presentations were made by field paramedic personnel, air ambulance flight nurses, local hospital emergency department physicians, and the Santa Clara Trauma Centers.

Methodology

Our methodology has remained the same as previous years.

Sources of Data:

EMS data is based on the WebPCR records completed by paramedics. The data is required to be entered within 24 hours of the patient encounter. There are 414 data fields on each PCR and most of the fields are auto-populated. The system is “live” 97% of the time.

CALSTAR and LifeFlight fax their patient care records within 24 hours of patient transport. In addition, CALSTAR sends a monthly report of all transports.

Once the WebPCR and air transport records are matched by the EMS Data Analyst the 3 Trauma Centers are contacted in order to obtain the clinical outcome data.

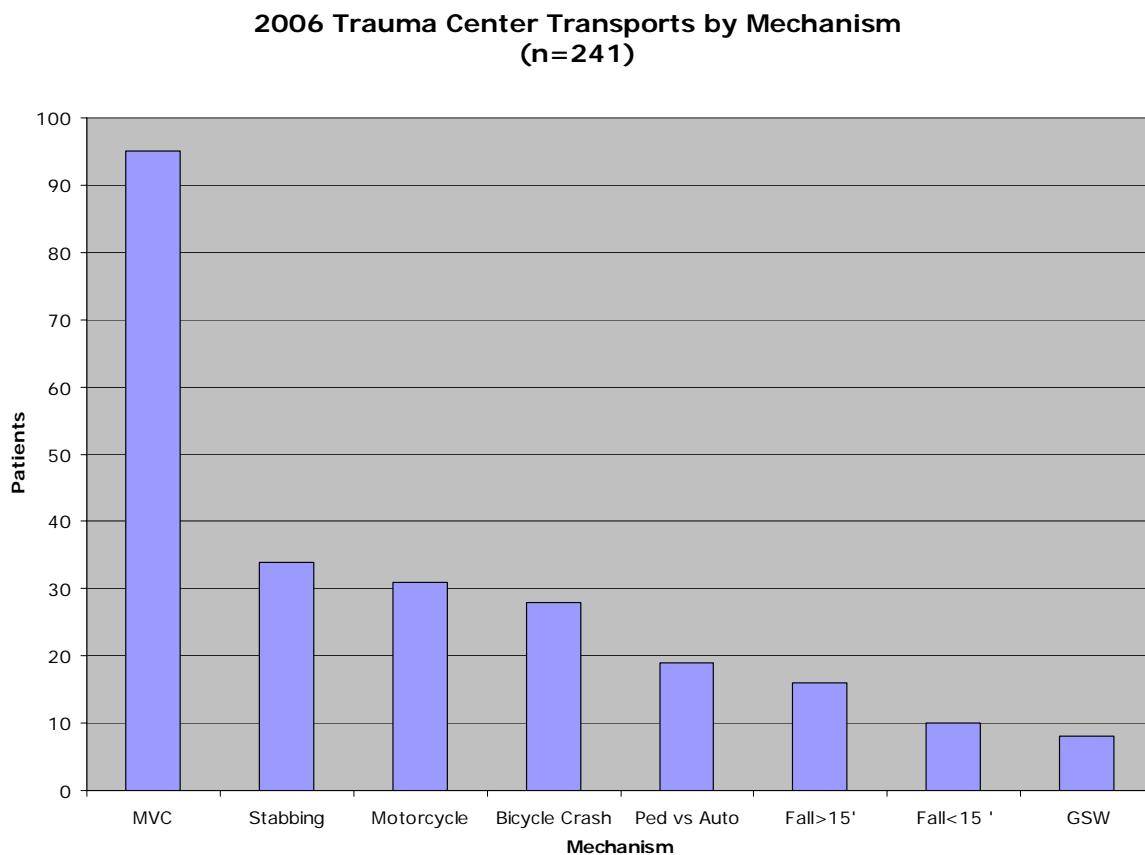
Dominican Hospital sends a monthly report of trauma admissions which were transported by EMS.

Data Analysis:

The EMS Data Analyst and the EMS Medical Director review all cases transported to the Trauma Centers where full outcome data is available. Clinical outcome data is used to determine the appropriateness of triage decisions and the issues of over- and under-triage. Transport data and hospital destination data is also analyzed. The EMS Medical Director reviews the data submitted by Dominican Hospital.

Mechanisms of Injury

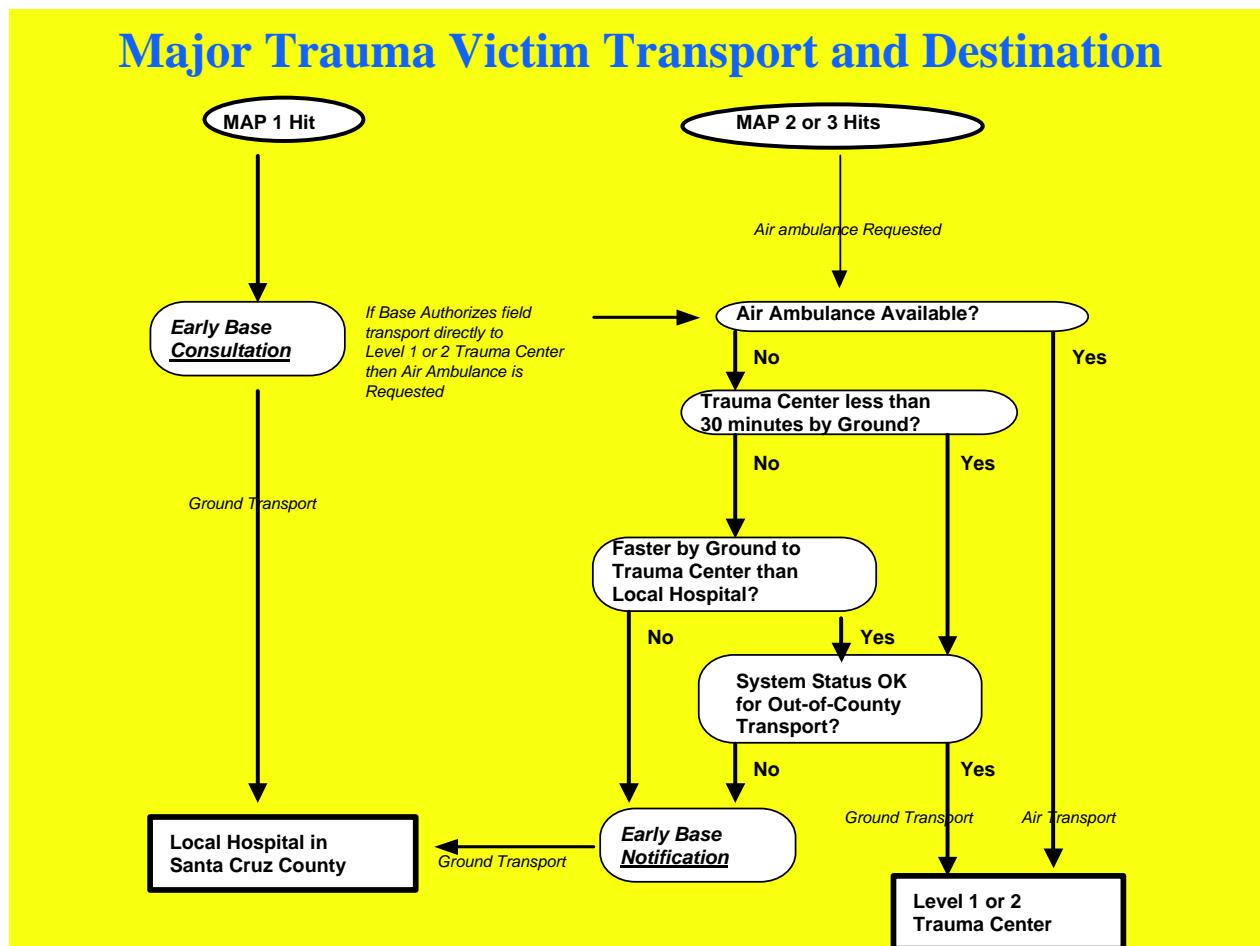
The most frequent mechanisms of injury resulting in Major Trauma Victims who are transported directly to Trauma Centers are as follows:



Trauma Triage

All three counties in the Monterey Bay Area use similar trauma triage criteria. In Santa Cruz County we have followed the guidance of the American College of Surgeons (ACS) in our approach to the trauma victim, i.e. that all Major Trauma Victims need to be rapidly transported to the most appropriate hospital capable of managing the needs of the victim. In order to reach this goal of rapid transport to the most appropriate hospital we have used a prehospital ‘trauma triage’ tool, called MAP scoring since May 1996. Over 500 EMT-I and EMT-Paramedic responders have been trained in the use of this tool. In late 2003, updated MAP training was provided to all Santa Cruz County paramedics and EMTs. This tool has been designed to guide field personnel in their assessment of trauma victims so that the victim’s injuries can be sorted into Major or Minor trauma. In general terms, any patient with 2 or 3 ‘hits’ on the MAP score is considered a Major Trauma Victim (MTV). However, in the case of a “minor” trauma victim who has only 1 ‘hit’ on the MAP score, the Base Hospital physician, during the paramedic’s call to the Base Hospital, may use his/her judgment to override the field MAP score and categorize the victim as having sustained Major Trauma based upon the paramedic’s description of the victim.

As soon as a person is determined to be a Major Trauma Victim (MTV), either by MAP scoring or Base Hospital physician judgment, then a series of actions occur. In general, the field personnel may transport the MTV by ground ambulance (depending on circumstance/time/distance) or activate a helicopter in order to rapidly transport the MTV to the most appropriate hospital capable of optimally managing the victim's injuries. Sometimes the most appropriate hospital is one of the two local community hospitals (Dominican Hospital or Watsonville Community Hospital), but most often the MTV is transported to one of the three designated Trauma Centers in Santa Clara County (Stanford University Hospital {SUH}, Santa Clara Valley Medical Center {VMC}, Regional Medical Center {RMC}).



Analysis of Trauma Data

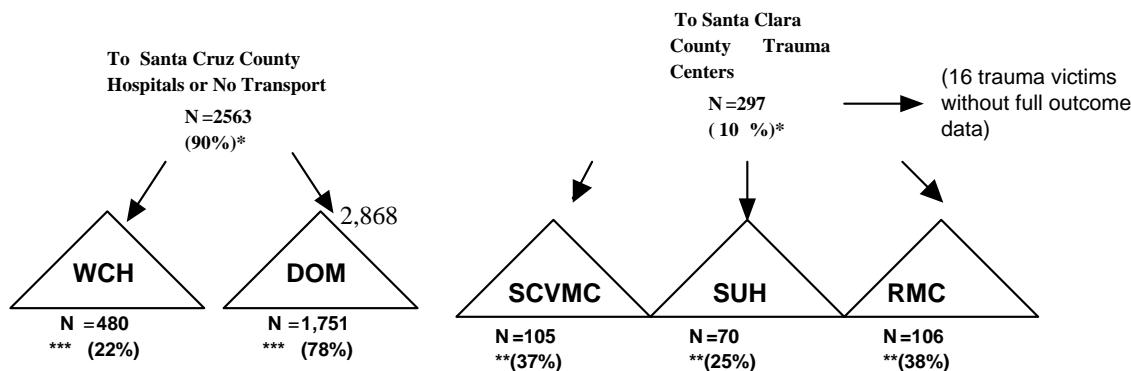
In 2006, there were 2,868 trauma victims transported to acute care hospitals by the EMS system. The vast majority of these patients (90%) stayed in Santa Cruz County (2,563), and 10% (297) were transported to Santa Clara County Trauma Centers. The distribution

of trauma transports within Santa Cruz County was 1,751 patients to Dominican Santa Cruz Hospital (78%) and 480 patients to Watsonville Community Hospital (22%).

| Santa Cruz EMS | Trauma Victim | Contacts | (Jan1,2006-Dec 31, 2006) |
|----------------|---------------|----------|--------------------------|
| N=2,860 | | | |

Destinations

note: 332 non-transports(AMA, RAS, Death Determined in Field)



* Percentages based on total unique trauma victim contacts Santa Cruz County EMS

** Percentages based on total field trauma victims transported to Santa Clara County TCs with full outcome data

***Percentages based on total field trauma victims transported to Santa Cruz County Hospitals

Overtriage and Undertriage:

Overtriage to Trauma Centers

Of concern in any trauma program are the rates of overtriage and undertriage. Briefly, overtriage measures the rate at which patients are field triaged as Major Trauma Victims (MTVs), but are subsequently found to have only minor trauma once evaluated at the hospital. In trauma care, it is known that in order not to miss cases of significant trauma there has to be a certain overtriage rate. That “acceptable” rate has been established at between 30-50%. Of course, the lowest overtriage rate possible is always the goal, but it has been shown that if the overtriage rate is too low, then there is an unacceptably high rate of “undertriage”, meaning that the field personnel did not identify victims who later proved to have major injuries. We have studied the overtriage rate for trauma victims transported to Santa Clara County Trauma Centers since 1996 and have detailed the data including Trauma Center outcome reports on 1145 trauma victims for 92 months. The Trauma Centers’ outcome data has proved invaluable in this analysis. The overtriage rate has varied between 17% and 32%. - in general, a rate lower than the 30-50% which most trauma experts consider reasonable for an optimal trauma system. For the year 2006, our

data from the Trauma Centers showed an overtriage rate of 32%. Consensus at the Trauma Review was that the overtriage rate remains within the acceptable range.

Last year, the Stanford University Trauma service reviewed our data and presented their analysis at a national forum - the **American Association for the Surgery of Trauma** Annual Meeting in September 2006. In addition, a paper describing our triage system will be published this year in the journal, **Prehospital Care**. The following matrices are used to evaluate our overtriage rate:

Transports to Trauma Centers in 2006

| 2006 Field Trauma Transports to Trauma Centers(1/1/06 - 12/31/06) | | | | | |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------|-------------|------------------------------------------------------------------------------|--|
| Data: | | | | | |
| 281 | Total EMS Trauma Patients Transported to Trauma Centers (full outcome data) | | | | |
| 265 | Total Major Trauma Victims* | | | | |
| 16 | Total Minor MAP score patients** | | | | |
| 179 | Total Major Trauma Victims(MTVs) and retrospectively classified as Major Trauma Patients*** | | | | |
| 8 | Total Minor MAP score patients and retrospectively classified as Minor Trauma Patients | | | | |
| 86 | Major MAP score patients retrospectively classified as Minor Trauma Patients | | | | |
| 8 | Minor MAP score patients retrospectively classified as Major Trauma Victims(MTV) | | | | |
| | | | | | |
| | | | | | |
| Undertriage and Overtriage Matrix | | | | | |
| Major Trauma Pts | | Minor Trauma Pts | | | |
| MTV | 179 | 86 | 265 | total MTV population(179 were Major Trauma Patients, 86 had Minor Trauma) | |
| Minor MAP | 8 | 8 | 16 | total Minor MAP population(8 were Major Trauma Patients, 8 had Minor Trauma) | |
| | 187 | 94 | 281 | total MAP score population | |
| | | | | | |
| Undertriage and Overtriage Results | | | | | |
| | | Numerator | Denominator | Result | |
| False negatives(Undertriage Rate) | | 8 | 187 | 4% of Major Trauma Patients were NOT predicted by a Major MAP score | |
| False positives(Overtriage Rate) | | 86 | 265 | 32% of MTVs found to have only Minor Trauma | |
| Predictive value of a Minor MAP score | | 8 | 16 | 50% | |
| Predictive value of a Major MAP score | | 179 | 265 | 68% | |
| | | | | | |

Transports to Trauma Centers over 92 Months

| 92 Months of Field Trauma Transports to Trauma Centers(5/1/96-4/30/97, 5/1/98-12/31/98, 1/1/00-12/31/00, 1/1/02-12/31/06) | | | | | | |
|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------|--------|--------------------------------------------------------------------------------|--|--|
| Data: | | | | | | |
| 1145 | Total EMS Trauma Patients Transported to Trauma Centers (full outcome data) | | | | | |
| 1059 | Total Major Trauma Victims* | | | | | |
| 86 | Total Minor MAP score patients** | | | | | |
| 784 | Total Major Trauma Victims(MTVs) and retrospectively classified as Major Trauma Patients*** | | | | | |
| 32 | Total Minor MAP score patients and retrospectively classified as Minor Trauma Patients | | | | | |
| 275 | Major MAP score patients retrospectively classified as Minor Trauma Patients | | | | | |
| 54 | Minor MAP score patients retrospectively classified as Major Trauma Victims(MTV) | | | | | |
| Undertriage and Overtriage Matrix | | | | | | |
| | Major Trauma Pts | Minor Trauma Pts | | | | |
| MTV | 784 | 275 | 1059 | total MTV population(784 were Major Trauma Patients, 275 had Minor Trauma) | | |
| Minor MAP | 54 | 32 | 86 | total Minor MAP population(54 were Major Trauma Patients, 32 had Minor Trauma) | | |
| | 838 | 307 | 1145 | total MAP score population | | |
| Undertriage and Overtriage Results | | | | | | |
| | Numerator | Denominator | Result | | | |
| False negatives(Undertriage Rate) | 54 | 838 | 6% | of Major Trauma Patients were NOT predicted by a Major MAP score | | |
| False positives(Overtriage Rate) | 275 | 1059 | 26% | of MTVs found to have only Minor Trauma | | |
| Predictive value of a Minor MAP score | 32 | 86 | 37% | | | |
| Predictive value of a Major MAP score | 784 | 1059 | 74% | | | |
| | | | | | | |

Undertriage to Dominican Hospital

In order to study undertriage for the year 2006 we had good quality outcome data from Dominican Hospital. In summary, there were 1,751 EMS trauma transports to Dominican, of which 79 were admitted to the hospital. There were 36 patients admitted who had 0 'hits' on their MAP triage score and there were 23 patients admitted who had 1 'hit' on their MAP triage score. Thus, using the ACS criteria, these were 59 trauma victims who were undertriaged as minor when in fact they were major.

Dominican admitted 20 Major Trauma Victims (MTVs with 2 or 3 MAP ‘hits’). The reasons why these MTVs were not transported to a Trauma Center are as follows:

- | | |
|----------------------------------------------|---------|
| Inclement weather (helicopter unable to fly) | 6 times |
| Base Physician Order | 7 times |
| Patient "In-Extremis" | 4 times |
| Unknown | 3 times |

A more detailed data analysis follows:

DSCH Data Analysis 2006
Trauma Transports/Admissions from EMS
(Outcome Data as Reported by DSCH)

Total Trauma Transports to DSCH 1751

Total Trauma Admissions from Transports (with outcome data) 79

| | |
|------------------|----|
| 0 Hit Admissions | 36 |
| 1 Hit Admissions | 23 |
| 2 Hit Admissions | 11 |
| 3 Hit Admissions | 09 |

2 Hit MAP Transported and Admitted to DSCH (N=11) – reasons why

| | |
|-------------------|---|
| No Helo (Weather) | 1 |
| Base MD Decision | 6 |
| Unknown | 3 |
| In-Extremis | 1 |

| | |
|-------|----|
| Total | 11 |
|-------|----|

2 Hit MAP Discharge Status (N=11)

| | | |
|--------------------|---|-----|
| Home from Hospital | 8 | 73% |
| Expired | 2 | 18% |
| Unknown | 1 | 9% |

3 Hit MAP Transported and Admitted to DSCH (N=9) – reasons why

| | |
|-------------------|---|
| In-Extremis | 3 |
| No Helo (Weather) | 5 |
| Base MD Decision | 1 |

| | |
|-------|----|
| Total | 09 |
|-------|----|

3 Hit Discharge Status (N=9)

| | | |
|------------------------------------|---|-----|
| Home from Hospital | 5 | 56% |
| Transfer to Trauma Center | 1 | 11% |
| Rehab (GSW to head -hemiplegia) | 1 | 11% |
| Expired (GSW pronounced in ED) | 1 | 11% |
| Unknown (Burns -no discharge data) | 1 | 11% |

Questions raised at Forum regarding Overtriage and Undertriage

What has been our historical Overtriage Rate?

| | |
|-----------|-----|
| 1997-2000 | 18% |
| 2002 | 23% |
| 2004 | 32% |
| 2005 | 28% |
| 2006 | 32% |

How do we explain our Overtriage Rate?

Q: Are too many “1” Hit MAP trauma victims with only minor injuries being sent to Trauma Centers?

A: In 2006 there were 59 patients with “1” Hit MAP scores transported to trauma centers compared with 210 patients with “2” or “3” Hits MAP scores. The overtriage rate of the “1” Hit MAP group was 47% compared with the “2” or “3” MAP Hits group who had an overtriage rate of 28%.

Q: “1” Hit MAP trauma victims who are transported to Trauma Centers need a specific order from the local Base Physician - are the paramedics following this policy?

A: In 2006, 46 had a Base Physician Order (78%) while 13 had no Base Physician Order (22%).

Q: Is the overtriage rate higher in “1” Hit MAP patients who are transported without a Base Physician Order?

A: The 46 patients transported to Trauma Centers with a Base Physician Order had an overtriage rate of 46% whereas the 13 patients transported without an order had an overtriage rate of 54%.

Q: Has there been an increase in percentage of “1” Hit MAP trauma victims being transported to Trauma Centers over the past 5 years?

A: Our data shows that the percentage of single hit MAP cases transported to Trauma Centers compared to all transports to Trauma Centers has varied between 15% and 21%.

| Year | "1" Hit MAP to Trauma Centers (% of Transports) | % Overtriage |
|------|-------------------------------------------------|--------------|
| 2002 | 15 | 36 |
| 2003 | 20 | 43 |
| 2004 | 20 | 39 |
| 2005 | 16 | 38 |
| 2006 | 21 | 47 |

Discussion:

As described earlier in this report, in Santa Cruz County we have developed triage policies which define Major Trauma Victims as patients who have “2” or “3” Hits on the MAP score and under most conditions they are to be transported directly from the field to a Trauma Center. However, we leave some discretion for the Base Physician to authorize a “1” Hit patient to be transported to a Trauma Center. In evaluating overtriage, we wondered if these single hit patients (21% of all our Trauma Center transports) contributed disproportionately to our overtriage rate. It doesn’t appear that we transported a significantly larger proportion of “1” Hit MAP patients in 2006 than in previous years. However the “1” Hit MAP patients were overtriaged at a higher rate than in previous years (47% in 2006 vs. average of 39% in 2002-2005). And it also is true that the “1” Hit MAP patients transported to Trauma Centers had a significantly higher overtriage rate compared to the “2” & “3” Hit patient (47% vs. 28%). It makes very little difference in the “1” Hit MAP overtriage rate whether or not a Base Physician has ordered the transport (overtriage of 46% with an order vs. 54% without). However, we do have a policy compliance issue when single hit patients are being transported to Trauma Centers without Base Physician authorization (22% had no order). Likewise we have a policy compliance problem when we transport patients directly to Trauma Centers who have no hits on the MAP trauma score (there were 12 such patients in 2006, 9 of which actually had a Base Physician Order to transport to a Trauma Center.) Those 12 patients had an overtriage rate of 50%. In summary, the data supports the contention that patients with “0” or “1” MAP Triage hits do contribute disproportionately to overtriage.

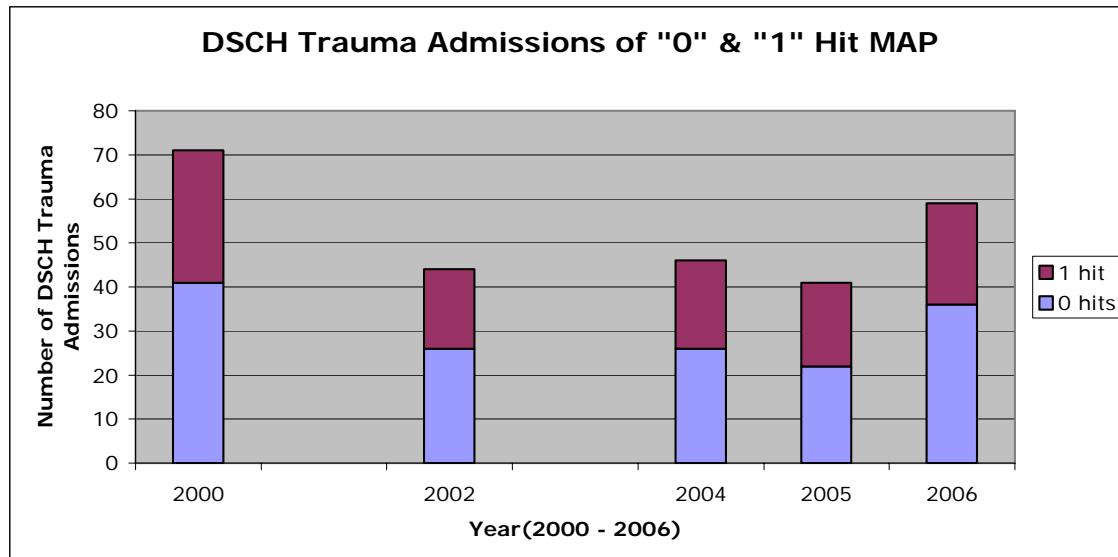
Management:

- 1) Policy issue - We need to investigate why medics are triaging zero or single hit MAP patients to Trauma Centers without base station authorization.
- 2) Clinical issue – We need to evaluate the Base Physician judgment on these cases so that we can better understand the rationale for the transport decision.

Undertriage Issues:

Q: Is there a trend towards more “0” or “1” Hit MAP patients requiring admission to Dominican Hospital (undertriage)?

A: Although “1” Hit MAP patients admitted to the hospital has remained low (23 out of 250 “1” Hit MAP patients transported to Dominican in 2006) it should be noted that 36 trauma patients were admitted with no hits.



| Year | Total | 0 hits | 1 hit |
|-------------|--------------|---------------|--------------|
| 2000 | 71 | 41 | 30 |
| 2002 | 44 | 26 | 18 |
| 2004 | 46 | 26 | 20 |
| 2005 | 41 | 22 | 19 |
| 2006 | 59 | 36 | 23 |

A review of the 36 “0” MAP Hit transports to DSCH in 2006 which required admission revealed:

Five (5) cases where medics erred by calling the case “medical” but were actually trauma.

Sixteen (16) cases of Fall<15’, or height unknown

Five (5) cases of Assault

Three (3) Bicycle crashes

Three (3) Motor Vehicle Crashes

Four (4) Miscellaneous Injuries

Q: Why were 20 “2” & “3” Hit MAP patients transported to Dominican Hospital when the policy states direct transport from field to Trauma Centers? Could any of these cases be considered undertriage?

A: The analysis shows that for 6 patients there was no air ambulance available due to weather. An additional 4 patients were in-extremis, where policy demands transport to closest hospital. There was no reason given for 3 patients. 7 patients were transported to Dominican by a Base Physician order. The only cases that might qualify for undertriage would be the ones directed to Dominican Hospital by Base Physician Order.

Discussion:

The most important part of triage analysis involves determining where our MAP Triage fails in identifying major trauma patients in the field. The trauma literature occasionally references this type of analysis, but is seldom goes into much detail regarding its methodology. Prehospital assessment schemes are prone to two types of error: **Operator Error** - failure to apply the assessment tool as written in policy/protocol and **Tool (MAP) Error** - failure of the tool itself to discriminate between a major and minor trauma patient. I would suggest that for our analysis we go further and divide the "failure to apply" error into subgroups of *Type 1 Error* - clinical evaluation failure to detect positive MAP criteria and *Type 2 Error* - failure to document on the MAP score sheet positive MAP criteria. In addition, our analysis should include what we have now come to call confounding issues which would impair the use of the MAP tool in the field. Finally, we need to review the hospital outcome data in order to see if there were any clinical consequences of the admission to a non-trauma center.

Types of Errors

Tool (MAP) Error:

Defined as appropriate use of the tool as written in protocol but failure of the MAP criteria to predict major trauma.

Operator Error:

Type 1 Error: Defined as clinical evaluation failure to detect positive MAP criteria.

Type 2 Error: Defined as failure to document on the MAP score sheet positive MAP criteria

Confounding Issues Error: Defined as the presence of comorbid factors such as advanced age, pre-existing disease, ETOH as a major complicating issue, situational scene factors such as the initial evaluation of patient taking place in a physician's office or at home or hours/miles away from the initial MVC, etc.

Clinical Consequences (of undertriage)

Was the patient, in spite of 'undertriage', managed properly from a clinical viewpoint? For example: Was there an early call to the base station for advice or as an alert? Were there appropriate field interventions? Was there appropriate transport urgency? (by ground or air). In the case of "isolated neuro", was the patient transported to an appropriate facility? Was the hospital outcome clinically appropriate?

Helicopter Utilization and Trauma Center Destinations

For the year 2006, we evaluated 281 air transports to Trauma Centers with Trauma Center outcome reports. CalStar transported 185 trauma victims and LifeFlight transported 96.

The Trauma Center destinations were: Regional Medical Center (RMC) 106 MTVs, Santa Clara Valley Medical Center (VMC) 105 MTVs, and Stanford University Hospital (SUH) 70 MTVs.

Comparing air ambulance flight data to previous years, we are finding that there has been a steady increase in our **documentation** of flights as well as an increasing number. We attribute this increase primarily to our improved ability to capture full outcome data on

our Major Trauma Victims transported to trauma centers. We also believe that the paramedics have continued to improve their assessment skills by appropriately identifying the MTVs for transport to trauma centers.

AIR AMBULANCE STATISTICS (Based on 281 Confirmed Transports with Trauma Center Outcome Data)

CALSTAR Transported 185 Patients = 66%
LIFEFLIGHT Transported 96 Patients = 34%

TRAUMA CENTER DISTRIBUTION

VMC (Santa Clara Valley Medical Center) Received 105 Patients = 37%
RMC (Regional Medical Center) Received 106 Patients = 38%
SUH (Stanford University Hospital) Received 70 Patients = 25%

HELICOPTER SERVICE PATIENT DESTINATIONS

CALSTAR (n=185) 71 patients to VMC = 39%
 106 patients to RMC = 59%
 4 patients to SUH = 2%

LIFEFLIGHT (n=96)
 29 patients to VMC = 30%
 0 patients to RMC = 0%
 66 patients to SUH = 70 %

Summary:

For the year 2006, Santa Cruz County EMS transported the vast majority of our trauma victims to our local hospitals. Our paramedics, using the trauma triage MAP tool, appropriately identified and called for transport of our **Major Trauma Victims** to the Level 1 and Level 2 Trauma Centers in Santa Clara County. Nevertheless, as outlined in the report, there are areas where we can improve, namely reducing the overtriage rate of "1 Hit MAP patients to trauma centers as well as reducing the number of patients with major injuries who are undertriaged in the field and subsequently transported to our local hospitals. These issues, among others will continue to challenge us to for the next years. The consensus of the CQI meeting was that Santa Cruz EMS continues to provide excellent oversight of our trauma system.