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Impact of Out-of-County Transports on Responses to Critical Incidents
Summit County, Colorado

Prepared for:

Summit County Ambulance Service
and
Area Fire Departments/Districts

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CONSULTANT REPORT

Impact of Out-of-County Transports on Reponses to Critical Priority Incidents
Summit County, Colorado

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INTRODUCTION

Summit County engaged Fitch & Associates (*FITCH*) to determine whether out-of-county patient transports interfere with the delivery of emergency service for critical emergency medical and fire related incidents within the County.

The original version of these analyses was completed in July 2016. A presentation of the original results was made to the Summit County Emergency Services Authority on October 6, 2016 by Dr. Erwin Stedronsky and Dianne Wright. Questions raised at this presentation resulted in the Authority requesting further analyses using an additional 15 CallTypeCodes. This addition to the roster of call types increased the number of incidents under consideration by 1,412 and the number of vehicle responses with units arrived at scene by 1,392. Compared to the original report, the analyses of "collisions" between fire incidents and TROUTs in this report were conducted with substantially increased numbers of data points leading to an increased reliability of the results.

TREATMENT OF DATA

Computer Aided Dispatch (CAD) records for the period June 01, 2015 through May 31, 2016 were provided by the County to the consultants in the form of multiple worksheets in an Excel *.xlsx file. These records were imported for analysis into Filemaker Pro Advanced version 14.0.5 running on a MacBook Pro with a 2.6 GHz quad core Intel i7 processor.

In this Report and its Attachments, out-of-county transports will be referred to as TROUT(s). "TROUT" is the CallTypeCode used in the County's CAD to refer to out-of-county transports. For brevity and parallelism, critical incidents will be referred to as CRIT(s). In the text of this report, the term "incident" refers to an emergency event in the field. The term "response" refers to the assignment of a unit to the incident. For many types of incidents, more than one unit will be assigned. Therefore, counts of "responses" will always be greater than counts of "incidents."

Master Incident Data Table

In order to facilitate the analyses required for this project, the Vehicles Assigned data table provided by the County was used to create a "Master Incident" data table in which each incident was represented by a single record. The procedure was to create a second data table using the Vehicle Assigned data and then delete records with duplicate EventNumbers. In this manner, 14,407 records in the Vehicles Assigned data table collapsed down to 7,407 records in the new Master Incident data table. The new Master Incident table was then relationally linked to the original Vehicle Assigned table using the EventNumbers as the selection parameters in order to pass summarized vehicular data back to the Master Incident record. The numbers of incidents in the Master Incident table with vehicles arrived at scene are presented below.

Figure 1. Master Incidents with Vehicles Arrived At Scene

Parameter	Count
Master Incident Records	7,407
Master Incident Records with Veh Arrvd AtScene	6,050
Vehicle Assigned Records	**14,407**
Vehicle Assigned Records with Veh Arrvd AtScene	8,911

A sample Master Incident record for both a FIRE and an EMS incident, as well as a Vehicle Assigned record are provided in Attachment A.

Critical Incidents

The County provided the consultants a list of CallTypeCodes to be considered in these analyses. The consultants were instructed to treat incidents with these CallTypeCodes as "critical" incidents, to be referred to as CRITs. The most recent update to this list was provided by the county's Director, Public Safety Division, on November 11, 2016. This list was used to construct a data table in consultant's database, which was then used to set a "Critical Incident" flag in records contained in both the Master Incident data table and the Vehicles Assigned data table. The numbers of critical incidents, as defined by the County, are shown in below.

Figure 2. Critical Incidents with Vehicles Arrived at Scene

Parameter	Count
Incidents with Critical Incident Flags	4,718
Incidents with Critical Incident Flags and Veh Arrvd AtScene	4,136

The ***initiation*** of a critical incident or CRIT is when vehicles are assigned to its response. If an out-of-county transport (TROUT) is to have an impact on a CRIT, it will be through interference with the assignment process. Thus, the two parameters that define how TROUTs interact with CRIT's are the "Hours per Year with TROUTs In-Progress" and the temporal distribution of the ***initiation*** of each response to the critical incident. The initiation of each response is taken as the dispatch timestamp of the unit(s) assigned to the incident.

Categories of Incident Types

For purposes of these analyses, the incidents in the CAD were divided into two broad categories: Emergency Medical and Fire All Hazards. The CallTypeCodes included in both these categories were vetted in discussions with County Public Safety officials.

Temporal Distributions of Critical Incidents

The temporal distributions of critical incidents were tabulated by month-of-year, day-of-week, and hour-of-day.

The greatest number of critical incidents coincided with the ski season, December 2015 through March 2016. The month of May had the lowest number of CRITs. There is an upswing in critical incidents on Fridays with a maximum on Saturdays. There is a spike in critical incidents at 1300 hours, with a broad maximum from 1200 through 1600 hours. The detailed tabulations of these temporal distributions are presented in Attachment B. Temporal Distribution of Critical Incidents.

Temporal Distributions of Out-of-County Transports

The figure below, presents TROUT related activity over the period of June 1, 2015 through May 31, 2016.

Figure 3. TROUT Incident Counts

Statistic	Count
TROUT Incident Records	781
TROUT Vehicle Responses	967
TROUT Transports of Patients	775

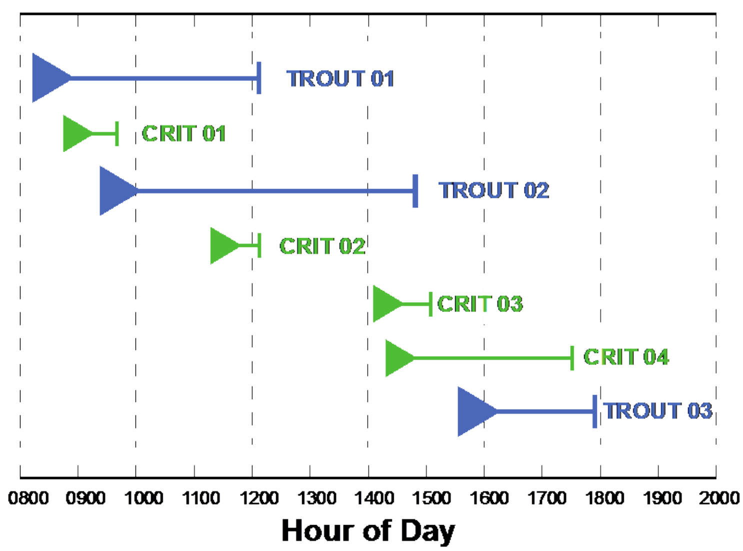
The Master Incident table was searched for incidents coded as involving out-of-county transports. Many of these incidents had an initial assignment of more than one unit. The final count of patients transported out-of-county was 775. The temporal distributions of out-of-county transport incidents were tabulated by month-of-year, by day-of-week, and by hour-of-day.

The number of out-of-county transports show spikes in December 2015 through March 2016, and again, the month of May had the minimum number. The number of out-of-county transports spike on Mondays and remain relatively steady the other days of the week. There is a deep minimum from 0200 hours through 0400 hours and a broad maximum from 1300 hours through 1700 hours. The detailed tabulations of these temporal distributions are presented in Attachment C, Temporal Distribution of Out-of-County Transport Incidents.

There are 775 Out-of-County transport incidents with vehicles arrived at scene, logged into the CAD from June 01, 2015 through May 31, 2016. Another 6 Out-of-County transports were assigned but cancelled before vehicles arrived.

The figure below, presents a schematic of the temporal relationship of TROUTs to TROUTs and TROUTs to CRITs. In this diagram, the triangles represent the dispatch time of the unit. The horizontal line represents the duration of the vehicle response. The vertical hash mark at the end of the line represents the clear timestamp. The number of overlaps between TROUTs that were seen in the data was unexpected because TROUTs were originally perceived by stakeholders to be temporally isolated from each other.

Figure 4. Temporal Relationship of TROUTs to CRITs



Given the concentration of TROUTs in the 1300 through 1700-time interval, the consultant decided to exactly tally the number of TROUTs that were simultaneous with other TROUTs (collisions) rather than relying on statistically based estimates of collisions.

The logic used in the search algorithm was the following:

1. Sort records in the Vehicle Assigned table by ascending dispatched timestamp [DS_TS],
2. Step through each record in the Vehicle Assigned table,
3. Identify individual records as TROUTs,
4. Acquire the clear timestamp [CL_TS] of the TROUT,
5. Search subsequent records for [DS_TS] with [DS_TS] < [CL_TS] of the TROUT,
6. Set the needed flags,
7. Return to the original TROUT record.
8. Continue stepping through the Vehicle Assigned table

In this manner, 310 TROUTs were identified as being simultaneous with other TROUTs. The figure below, presents the numbers of TROUTs that were simultaneous with other TROUTs.

Figure 5. Number of TROUTs Simultaneous with Other TROUTs

TROUTs Simultaneously In-Progress	*Additional* TROUTs Simultaneous with this TROUT	Instances	Percent of Total
1	**0**	**465**	**60.0%**
2	1	216	27.9
3	2	80	10.3%
4	3	11	1.4%
5	4	3	0.4%
Subtotal		**310**	**40.0%**
Totals		**775**	**100.0%**

Most of the TROUTs (60.0%) occur singularly with no simultaneous TROUT. A surprising aspect of the data in the figure above is the number of instances during which two TROUTs are in-progress at the same time (27.9%) There are even 94 instances with three or more TROUTs in-progress simultaneously. In total, there are 310 instances when there is more than one TROUT in-progress (40.0%) simultaneously.

A parameter of interest is what percentage of hours in the year have one or more TROUT incidents in-progress. The number of simultaneous TROUTs shown above, means that simply multiplying the annual count of TROUTs by the average Time-on-Task per TROUT will give an answer that is too large due to the overlaps. This block of time must be explicitly tallied by stepping through the CAD one incident at a time, summing TROUT durations, and subtracting overlaps.

The logic used in the search algorithm was the following:

1. Step through each incident record in the Vehicles Assigned table,
2. Identify whether the incident was a TROUT with a patient transported and add to the running total of durations,
3. Find the second TROUT in sequence and add to the running total of durations,
4. Test for overlap between the first and second TROUT,
5. Subtract the overlap from the running total of TROUT durations,
6. Designate the second TROUT as a "new" first TROUT,
7. Return to stepping through the Master Incident table.

In this manner, the running total of TROUT durations for the period June 01, 2015 through May 31, 2016, corrected for overlaps, was tallied as 2594 hours 40 minutes and 28 seconds (2594:40:28). These results are provided below.

Figure 6. Running Total of TROUT Durations Corrected for Overlaps

Ln	Parameter Name	Count	Value
2	TROUTs with Veh Arrvd AtScene	775	
3	TROUTs simultaneous with previous TROUT's	310	40.0%
4	TROUT Time-on-Task at 50th %-tile (Average) [hh:mm:ss] ± Standard Deviation		04:20:47 ± 01:15:29
5	TROUTs Block Time Durations per CAD Hrs:Min:Sec (corrected for overlapping TROUT incidents)		2,594:40:28
6	Percent of Hours in Year with one or more TROUTs In-Progress (corrected for overlapping TROUT incidents)		30.0%

Out-of-county transports occur in Summit County for about 2,595 hours out of the 8,760 hours in the year, which represents about 30.0%.

CRITICAL INCIDENTS SIMULTANEOUS WITH TROUTS

Critical incidents simultaneous with out-of-county transports will be referred to "CRITs X TROUTs". The distribution of TROUTs by month, day-of-week, and hour-of-day is complex. Likewise, the distribution of CRITs is complex. Given the multiple complexities, there is no simple "back-of-the-envelope" method to estimate "collisions" between TROUT and CRIT incidents. Enumeration of collisions required conducting an exact tally that was obtained by stepping through the CAD one incident at a time.

The logic used in the search algorithm was the following:

1. Sort records in the Vehicle Assigned table by ascending dispatched timestamp [DS_TS],
2. Step through each record in the Vehicle Assigned table,
3. Identify individual records as TROUTs,
4. Acquire the clear timestamp [CL_TS] of the TROUT,
5. Search subsequent records for [DS_TS] with [DS_TS] < [CL_TS] of the TROUT,
6. Set the needed flags,
7. Return to the original TROUT record,
8. Continue stepping through the Vehicle Assigned table.

In this manner, 1,184 "collisions" were identified between TROUTs and CRITs in the CAD for the period June 01, 2015 through May 31, 2016. The distribution of these collisions is presented, below.

Figure 7. Distribution of TROUT and CRIT Collisions June 01, 2015 Through May 31, 2016

Parameter	Count	
	Incidents	Unit Responses
CRITs with Vehicles Arrived AtScene	4,136	
CRIT EM with Veh Arrvd AtScene	2,807	
Vehicle responses to CRIT EM		4,491
CRIT FR with Veh Arrvd ATScene	1,285	
Vehicle responses to CRIT FR		1,788
CRIT nFR/nEM with Veh Arrvd AtScene	44	
Vehicle responses to CRIT nFR/nEM		100
CRIT EM with Veh Arrvd AtScene SimW[1] TROUT	1,091	
Vehicle responses to CRIT EM SimW TROUT		1,643
CRIT FR with Veh Arrvd AtScene SimW[1] TROUT	465	
Vehicle responses to CRIT FR SimW TROUT		626
CRIT nFR/nEM with Veh Arrvd AtScene SimW TROUT	21	
Vehicle responses to CRIT nFR/nEM		30

[1] "SimW TROUT" =Simultaneous with TROUT

The temporal distributions of critical incidents that were simultaneous with out-of-county transport incidents were tabulated by month-of-year, day-of-week, and hour-of-day. The greatest number of CRITs that occurred simultaneously with TROUTs coincide with the ski season, December through March. There is a deep minimum in May. The maximum numbers occur on Fridays and Saturdays. For each day other than Tuesday, there are at least 150 CRITs simultaneous with out-of-county transports. Hourly spikes occur at 1300 to 1700 hours with minimums at 0100 to 0800 hours. Attachment D provides the temporal distributions for CRITs simultaneous with TROUTs.

The distributions of CallTypeCodes for the CRITs simultaneous with TROUTs are presented by category of incident codes as Emergency Medical and Fire Suppression in Attachment E, Counts of Incident Code Types. The incidents in this attachment include those where a Vehicle did not arrive on scene. The three most numerous CallTypeCodes appearing in the Emergency Medical list are MEDIC, TRANS2, and TRANSF. These three CallTypeCodes account for more than half of all the incidents appearing in this list. The three most numerous CallTypeCode appearing in the Fire list is ALMCO, ALMRES, and ALARMC.

Summary Statistics

The figure below, summarizes the statistics developed from Summit County CAD data for June 01, 2015 through May 31, 2016.

Figure 8. Summary Statistics Developed from CAD Data June 01, 2015 Through May 31, 2016

Types of Incidents	Count	Percent ofTotal Master Incident Records
All Master Incident Records	**7,407**	
All Master Incident Records with Veh Arrvd AtScene	6,050	81.7%
Critical Incident with Veh Arrvd AtScene	**4,136**	
Em Med	2,807	67.9%
FR	1,285	31.1%
nFR/nEM	44	1.0%
Out-of-County Transports with Veh Arrvd AtScene	**775**	
TROUTs Simultaneous with TROUTs	310	40.1%
Block Hours per Year with TROUTs In-Progress	2,595 hrs.	
Percent of Year with TROUTs In-Progress	30.0%	
CRITs Simultaneous with TROUTs	**2,299**	
Em Med	1,643	71.5%
FR	626	27.2%
nFR/nEM	30	1.3%

The two parameters that define how out-of-county transports interact with critical incidents are the "Hours per Year with TROUT's In-Progress" and the temporal distribution of the ***initiation*** of each critical incident.

Metric for Comparisons

The initiation of a CRIT is when vehicles are assigned to its response. If a TROUT is to have an impact on a CRIT, it will be through interference with this assignment process. If TROUTs cause a scarcity of resources in Summit County, dispatchers may be compelled to take one of two undesirable actions when dealing with the next request for emergency services. They may stack responses onto units already running a response in-progress. They may assign units that would normally be considered too remote to the response. In both cases, the observable characteristic appearing in the CAD will be that the response interval will increase compared to normal operations.

Thus, response intervals are used as the metric to judge the impact of out-of-county transports on critical incidents in the system. Specifically, average response intervals for all units arrived at scene are used rather than the more commonly encountered response interval for the first unit arrived at scene. Analyses of response intervals was limited to critical fire incidents and critical emergency medical incidents, as defined by the County.

The selection of response intervals for *all* units arrived at scene was made to embrace the complexity of fire all hazard responses, whereby a "package" of multiple units must be assembled at scene in order to constitute an effective response. The metric of first arrived at scene is inadequate to represent whether out-of-county transports interfere with assembling the effective response force required in fire all hazard incidents.

The County experiences a small number of in-county incidents with "long" duration individual unit response intervals. The consultant's experience is that all systems experience long duration outliers that are atypical and do not reflect routine operations. Including all long duration outliers in the response time statistics has two consequences. First, inclusion moves the average response time to a longer value. Second, inclusion dramatically increases the standard deviations about the averages. The concern is that such atypical events would obscure any real affects that TROUTs may have on CRITs.

The source of the concern arises from the mathematics needed to determine the probability that two distributions of response times are the same or different. The methodology used to make this decision is the t-Test. The magnitude of the t-value in the t-Test is highly dependent on the standard deviations of the distributions being examined. When the standard deviations "blow up" because of long duration outliers, the ability to tell that two distributions really are different is lost. All distributions of response times become indistinguishable regardless of whether real and systematic differences actually exist. The ability to perceive the signal is lost when the noise in the dataset gets magnified by the outliers. The question then becomes: "What yardstick to apply to the data in the CAD to distinguish long duration outliers?"

Filters for Long Duration Outliers

The approach taken in the expanded analyses of this report is to evaluate Em Med and FIRE response intervals separately. The first step is to consider the response intervals of all vehicles arrived at scene on FIRE incidents. These are sorted into ascending order and the median interval determined. A similar process was applied to vehicles arrived at scene on Em Med incidents. These median intervals are presented below. In other studies, *FITCH* has used a value of three times the median as the criterion (3X Median) to identify a long duration outlier as an event that is atypical and does not reflect normal operations.

Figure 9. Median FIRE and Em Med Response Intervals for all Vehicles Arrived AtScene

Incident Type	Median Response Interval [seconds] [hh:mm:ss]	3X Median
FR	396 sec [00:06:36]	1,188 sec
Em Med	450 sec [00:07:30]	1,350 sec

The outcome of applying the 3X Median criterion to the FIRE and EM Med response intervals is presented below.

Figure 10. Filters for Long Duration Outliers on FIRE Response Intervals

Max Response Interval (sec) [hh:mm:ss]	FIRE Vehicles Arrived AtScene	Instances Excluded	Percent Instances Retained
Unlimited	1,788		
10,800 [03:00:00]	1,767	21[1]	100.0%
7200 [02:00:00]	1,762	5	99.7%
3600 [01:00:00]	1,759	3	99.5%
1584 (4X Median)	1,719	40	97.3%
1188 (3X Median)	1,681	38	95.1%

[1] These incident records are missing a dispatched timestamp. No response interval can be determined.

Figure 11. Filters for Long Duration Outliers on EM Med Response Intervals

Max Response Interval (sec) [hh:mm:ss]	Em Med Vehicles Arrived AtScene	Instances Excluded	Percent Instances Retained
Unlimited	4,491		
10,800 [03:00:00]	4,457	34[1]	100.0%
7200 [02:00:00]	4,456	1	100.0%
3600 [01:00:00]	4,445	11	99.7%
1800 (4X Median)	4,363	82	97.9%
1350 (3X Median)	4,199	164	94.2%

[1] These incident records are missing a dispatched timestamp. No response interval can be determined.

The 3X Median filter appears to be a good compromise between retaining a high percentage of instances and controlling growth of the stand deviations in the statistics describing the data sets.

Consequences of Out-of-County Transports

The numbers of vehicles arrived at scene, average response times, and standard deviations, for emergency medical and fire all hazard critical incidents with simultaneous out-of-county transports, are presented below.

Figure 12. Average Response Intervals for CRITs Units Arrived AtScene with and without TROUTs

	Subset of Response Intervals	Vehicles Arrived AtScene	Average (seconds) and [mm:ss]	± Std Dev (seconds) and [mm:ss]
1	EM SimW TROUT[1] = 0	2,678	485 [08:05]	±294 [±04:54]
2	EM SimW TROUT = 1	1,104	515 [08:35]	±313 [±05:13]
3	EM SimW TROUT = 2+	1417	547 [09:07]	±335 [±05:35]
4	FR SimW TROUT = 0	1,097	439 [07:19]	±263 [±04:23]
5	FR SimW TROUT = 1+	584	415 [06:55]	±247 [±04:07]

[1] "SimW TROUT" = Simultaneous with TROUT

An inspection of the results above shows that there are differences between the averages for both FIRE and Emergency Medical incidents with or without TROUTs. In all cases, however, the averages are flanked by pronounced standard deviations.

Simply looking at the averages without consideration for the standard deviations does not tell the story. To illustrate the difficulty of casual interpretation, consider Line 4 and Line 5 in Figure 12 above. Line 4 is the base case for FIRE vehicles arrived at scene without a simultaneous TROUT. Line5 is FIRE vehicles arrived at scene with at least one simultaneous TROUT. The 415 second average on Line 5 is less than the 439 second average on Line 4. The conclusion from a casual interpretation of this pair of averages is that having an ambulance driving back and forth to Denver on I-70 "magically" improves FIRE response times back in Summit County. The point of this example is that making sense of the data in Figure 12 requires more rigorous methods than casual interpretation. Fortunately, these methods are available.

The t-Test is a standard statistical method for assigning a probability to whether two distributions are the same or different. In the case of Summit County, two comparisons of distributions are important: response intervals on Em Med incidents with and without TROUTs, as well as response intervals on FR incidents with and without TROUTs

The t-values and p-values associated with the t-Test are included in the figure below. The method for calculating t-values and the table for correlating t-values to p-values are presented in Attachment F. The p-value is the probability, expressed as a decimal, that two distributions are actually different. In the context of Summit County, small p-values mean that TROUTs have a very small probability of actually having affected CRITs. The figure below repeats the data from Figure 11 and now includes the t-value and p-value.

Figure 13. Average Response Times for Units Arrived AtScene Including t-value and p-value

	Subset of Response Intervals	Vehicles Arrived AtScene	Average (seconds) and [mm:ss]	± Std Dev (seconds) and [mm:ss]	t-Value	p-value
1	EM SimW TROUT[1] = 0	2,678	485 [08:05]	±294 [±04:54]	Base case	
2	EM SimW TROUT = 1	1,104	515 [08:35]	±313 [±05:13]	2.727	0.012
3	EM SimW TROUT = 2+	1417	547 [09:07]	±335 [±05:35]	3.571	<0.001
4	FR SimW TROUT = 0	1,097	439 [07:19]	±263 [±04:23]	Base case	
5	FR SimW TROUT = 1+	584	415 [06:55]	±247 [±04:07]	1.255	0.034

Comparing Line 2 to Line 1 above there is a 98.8%[1] probability that one simultaneous TROUT has NO impact on response intervals to critical emergency medical incidents in Summit County. Comparing Line 3 to Line 1 above there is more than a 99.9%[2] probability that two or more simultaneous TROUTs have NO impact.

Comparing Line 5 to Line 4 in the figure above, there is a 96.6%[3] probability that one or more simultaneous TROUTs have NO impact of response intervals to critical fire incidents in Summit County.

[1] Calculated from the p-value (line 2) as [1.000 – 0.012]x100%.

[2] Calculated from the p-value (line 3) as [1.000 – 0.001]X100%.

[3] Calculated from the p-value (line 5) as {1.000 – 0.034]X100%.

CONCLUSION

The conduct of out-of-county transports undoubtedly imposes a burden on emergency service resources in Summit County. Nevertheless, with ambulances and personnel frequently traveling back and forth to Denver, there remains a sufficiency of resources within Summit County to execute normal emergency service operations and experience no increases to response intervals. This is the case for both critical emergency medical and critical fire related incidents.

ATTACHMENT A

Sample Master Incident Records

and Vehicle Assigned Record

FITCH & ASSOCIATES

Attachment A.

Sample Master Incident and Vehicle Assigned Records

Figure 14. Sample Master Incident Record for an Emergency Medical Incident

Summit County 911
CAD Master Incidents

Record Number	Date	Time	Year	Mo	Day	Day Name	Day of Wk	Week End	Hr of Day	Hour of Yr
375	06/01/2015	13:53:02	2015	1	1	Mon	2	0	13	3,638

EventNumber	FLD150601002046	Master	1	Code	Category	Critical Incident
CallType	EMERGENT CONVULSIONS			12C	Em Med	1

Agency	AMBULANCE SERVICE	LD
Disposition	CLEAR	CLR
Address	185 STEPHENS WAY	
LocationText	BURGER KING	

IncidentTimeCreated	IncidentTimeClosed
06/01/2015 13:53:02	06/01/2015 14:58:29

Simultaneous With Out-of-County Transport Incident: [EventNumbers]	
1	FLD150601002043
2	FLD150601002044
3	
4	
5	
6	
Count	2

Vehicles	
Assgn	Arrvd
3	2

Portal to Vehicles Assigned Table

Unit	Dispatched	Arrvd AtScene	Arrvd Hospital	Cleared	Out of County Transport Interval
A1	06/01/2015 13:54:35	06/01/2015 13:59:14	06/01/2015 14:30:46	06/01/2015 14:58:29	
E8	06/01/2015 13:53:10	06/01/2015 13:57:56		06/01/2015 14:17:39	
A3	06/01/2015 13:53:11			06/01/2015 13:54:32	

Figure 15. Sample Master Incident Record for a Fire Related Incident

Summit County 911
CAD Master Incidents

Record Number	Date	Time	Year	Mo	Day	Day Name	Day of Wk	Week End	Hr of Day	Hour of Yr
2,025	08/28/2015	16:36:25	2015	3	28	Fri	6	0	16	5,753

EventNumber	FLD150828003185	Master	1	Code	Category	Critical Incident
CallType	VEHICLE FIRE			FIREV	FIRE	1

Agency	LDFA SILVERTHORNE/DILLON	LD
Disposition	CLEAR	CLR
Address	990 LAKEPOINT DR	
LocationText	RAMADA INN	

IncidentTimeCreated	IncidentTimeClosed
08/28/2015 16:36:25	08/28/2015 18:06:10

Simultaneous With Out-of-County Transport Incident: [EventNumbers]	
1	FLD150828003184
2	
3	
4	
5	
6	
Count	1

Vehicles	
Assgn	Arrvd
5	3

Portal to Vehicles Assigned Table

Unit	Dispatched	Arrvd AtScene	Arrvd Hospital	Cleared	Out of County Transport Interval
LD3	08/28/2015 17:40:26	08/28/2015 17:40:31		08/28/2015 18:06:10	
E8	08/28/2015 16:36:46	08/28/2015 16:45:23		08/28/2015 17:39:55	
BAT8	08/28/2015 16:38:04	08/28/2015 16:48:43		08/28/2015 16:54:43	
E11	08/28/2015 16:37:44			08/28/2015 16:44:16	
E4	08/28/2015 16:37:36			08/28/2015 16:37:52	

Figure 16. Sample Vehicle Assigned Record

Summit County 911
CAD Vehicles Assigned

Record	Date	Time	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr
35,893	06/01/2015	13:53:02	1	1	Mon	2	13	3,638

		Code	Critical Incident	Priority
EventNumber	FLD150601002046			
CallType	EMERGENT	12C	1	1
Category	Em Med			

Agency	AMBULANCE SERVICE	LD
Disposition	CLEAR	CLR
Address	185 STEPHENS WAY	
LocationText	BURGER KING	

UnitName: A1 | 0 | TROUT_Tr_Unit

IncidentTimeCreated	06/01/2015 13:53:02	
UnitTimeDispatch	06/01/2015 13:54:35	
UnitTimeEnroute	06/01/2015 13:54:45	
UnitTimeArrived	06/01/2015 13:59:14	
itTimeEnrouteHospital	06/01/2015 14:16:19	
nitTimeArrivedHospital	06/01/2015 14:30:46	
UnitTimeCleared	06/01/2015 14:58:29	01:03:54 Time-on-Task
IncidentTimeClosed	06/01/2015 14:58:29	

LDO Cutoff	Response Time
1350	279 sec

Average over all Response Times for Found Set	
524	± 319

	Avg	± Std Dev
Time-on-Task	00:49:32	± 00:39:42

Simultaneous With Out-of-County Transport Incident: [EventNumbers]		
	1	FLD150601002043
	2	FLD150601002044
	3	
	4	
	5	
	6	
Count	2	

Hours with 1 or more Out-of-County transports running simultaneously	2594:40:28

1 Used to create master incident record.

ATTACHMENT B

Temporal Distribution of Critical Incidents

FITCH & ASSOCIATES

Attachment B.

Temporal Distribution of Critical Incidents

Figure 17. Critical Incident by Month-of-Year with Vehicles Arrived AtScene

Month	Critical Priority Incidents	Fraction Annual
Jun	272	0.066
Jul	341	0.082
Aug	292	0.071
Sep	224	0.054
Oct	198	0.048
Nov	274	0.066
Dec	516	0.125
Jan	525	0.127
Feb	516	0.125
Mar	499	0.121
Apr	302	0.073
May	177	0.043
	4,136	

Figure 18. Critical incidents by Day-of-Week with Vehicles Arrived AtScene

Day	Critical Priority Incidents	Fraction Weekly
Sun	614	0.148
Mon	597	0.144
Tue	472	0.114
Wed	518	0.125
Thu	549	0.133
Fri	655	0.158
Sat	731	0.177
	4,136	

Figure 19. Critical Incidents by Hour-of-Day with Vehicles Arrived AtScene

Hour	Critical Priority Incidents	Fraction Daily
0000	78	0.019
0100	76	0.018
0200	73	0.018
0300	71	0.017
0400	50	0.012
0500	41	0.010
0600	66	0.016
0700	111	0.027
0800	152	0.037
0900	166	0.040
1000	208	0.050
1100	253	0.061
1200	329	0.080
1300	348	0.084
1400	322	0.078
1500	269	0.065
1600	278	0.067
1700	257	0.062
1800	208	0.050
1900	189	0.046
2000	187	0.045
2100	168	0.041
2200	120	0.029
2300	116	0.028
	4,136	

ATTACHMENT C

Temporal Distribution of Out-of-County Transports Incidents

FITCH & ASSOCIATES

Attachment C.
Temporal Distribution of Out-of-County Transport Incidents

Figure 20. Out-of-County Transports by Month-of-Year

Month	Out of County Transports	Fraction Annual
Jun	45	0.058
Jul	70	0.090
Aug	42	0.054
Sep	43	0.055
Oct	43	0.055
Nov	49	0.063
Dec	89	0.115
Jan	99	0.128
Feb	89	0.115
Mar	112	0.145
Apr	58	0.075
May	36	0.046
	775	

Figure 21. Out-of-County Transports by Day-of-Week

Day	Out of County Transports	Fraction Weekly
Sun	99	0.128
Mon	141	0.182
Tue	85	0.110
Wed	110	0.142
Thu	109	0.141
Fri	111	0.143
Sat	119	0.154
	774	

Figure 22. Out-of-County Transports by Hour-of-Day

Hour	Out of County Transports	Daily Fraction
0	25	0.032
1	13	0.017
2	10	0.013
3	9	0.012
4	6	0.008
5	11	0.014
6	11	0.014
7	15	0.019
8	14	0.018
9	19	0.025
10	36	0.046
11	47	0.061
12	40	0.052
13	61	0.079
14	51	0.066
15	71	0.092
16	66	0.085
17	55	0.071
18	44	0.057
19	50	0.065
20	47	0.061
21	25	0.032
22	32	0.041
23	17	0.022
	775	

ATTACHMENT D

Temporal Distribution of Critical Incidents Simultaneous with Out-of-County Transports

Attachment D.

Temporal Distribution of Critical Incidents Simultaneous with Out-of-County Transports

Figure 23. Critical Incidents Simultaneous with Out-of-County Transports by Month-of-Year

Month	Critical Priority Incidents	Fraction Annual
Jun	62	0.052
Jul	74	0.063
Aug	53	0.045
Sep	36	0.030
Oct	30	0.025
Nov	58	0.049
Dec	161	0.136
Jan	187	0.158
Feb	188	0.159
Mar	233	0.197
Apr	79	0.067
May	21	0.018
	1,182	

Figure 24. Critical Incidents Simultaneous with Out-of-County Transports by Day of Week

Day	Critical Priority Incidents	Fraction Weekly
Sun	284	0.124
Mon	362	0.157
Tue	229	0.100
Wed	290	0.126
Thu	300	0.130
Fri	431	0.187
Sat	403	0.175
	2,299	

Figure 25. Critical Incidents Simultaneous with Out-of-County Transports by Hour-of-Day

Hour	Critical Priority Incidents	Fraction Daily
0000	55	0.024
0100	36	0.016
0200	18	0.008
0300	14	0.006
0400	16	0.007
0500	4	0.002
0600	11	0.005
0700	6	0.003
0800	39	0.017
0900	41	0.018
1000	62	0.027
1100	102	0.044
1200	141	0.061
1300	215	0.094
1400	176	0.077
1500	165	0.072
1600	217	0.094
1700	205	0.089
1800	175	0.076
1900	172	0.075
2000	174	0.076
2100	126	0.055
2200	59	0.026
2300	70	0.030
	2,299	

ATTACHMENT E

Counts of

Incident Code Types

FITCH & ASSOCIATES

Attachment E.

Counts of Incident Code Types

Figure 26. Call Type Codes for Emergency Medical CRITs without Simultaneous TROUTs

Code	Call Type Text	Count
10C	EMERGENT CHEST PAIN	36
10D	EMERGENT CHEST PAIN	36
11D	EMERGENT CHOKING	2
12C	EMERGENT CONVULSIONS	19
12D	EMERGENT CONVULSIONS	29
13C	EMERGENT DIABETIC	9
13D	EMERGENT DIABETIC	1
17D	EMERGENT FALLS	33
18C	EMERGENT HEADACHE	4
19C	EMERGENT HEART PROBL	14
19D	EMERGENT HEART PROBL	12
1C	EMERGENT ABDOMINAL P	12
1D	EMERGENT ABDOMINAL P	1
20D	EMERGENT EXPOSURE	1
21D	EMERGENT HEMORRHAGE	7
23C	EMERGENT OD/POISON	17
23D	EMERGENT OD/POISON	1
25D	EMERGENT PSYCHIATRIC	2
26C	EMERGENT SICK	37
26D	EMERGENT SICK	13
28C	EMERGENT STROKE	17
2C	EMERGENT ALLERGIES	8
2D	EMERGENT ALLERGIES	6
30D	EMERGENT TRAUMATIC I	8
31C	EMERGENT UNC/FAINT	22
31D	EMERGENT UNC/FAINT	61
32D	EMERGENT UNKNOWN PRO	5
5D	EMERGENT BACK PAIN	1
6C	EMERGENT BREATHING P	26
6D	EMERGENT BREATHING P	80
7C	EMERGENT BURNS	1
8D	EMERGENT GAS	1
9D	EMERGENT CARDIAC	1
ECHOB	EMERGENT BREATHING P	3
ECHOC	ECHO CARDIAC	34
ECHOO	ECHO CHOKING	1
EMVA	EMERGENT MOTOR VEHIC	146
MASS2	MASS CASUALTY 2ND AL	1
MEDIC	MEDIC	559
TERA2	CRITICAL CARE TRANSP	66
TRANS1	LEVEL 1 TRANSPORT	15
TRANS2	LEVEL 2 TRANSPORT	214
TRANSF	IN COUNTY TRANSFER F	208
TRANSO	IN COUNTY TRANSFER F	87
		1857

Figure 27. Call Type Codes for Fire Related CRITs without Simultaneous TROUTs

Code	Call Type Text	Count
ALARMC	CO ALARM RESPONSE	94
ALMCO	COMMERCIAL FIRE ALAR	310
ALMRES	RESIDENTIAL FIRE ALA	195
ELVTR	ELEVATOR PROBLEM, NO	8
ELVTRP	ELEVATOR ALARM/PROBL	30
FASSIM	FD ASSIST TO OTHER A	21
FASSIP	FIRE PUBLIC ASSIST	65
FIRED	DUMPSTER FIRE	2
FIRES1	FIRST ALARM STRUCTUR	27
FIRET	FIRE IN THE TUNNEL	1
FIREV	VEHICLE FIRE	56
FIREW	WILDLAND FIRE	19
FIREW2	SECOND ALARM WILDLAN	4
GASLK	NATURAL GAS/PROPANE	17
GASOD	NATURAL GAS/PROPANE	55
HAZCH	HAZARDOUS CHEMICAL M	2
HAZMAT	HAZMAT INCIDENT	8
POWER	POWER LINES DOWNS	5
SMESM	SMELL OF BURNING/SMO	27
SMOKE	OUTDOOR SMOKE SIGHTI	40
SPILL	COMMON FLAMMABLE LIQ	30
SPRNKC	SPRINKLER WATER FLOW	29
SPRNKR	SPRINKLER WATER FLOW	4
SWIFT	SWIFT WATER RESCUE C	5
		1054

Figure 28. Call Type Codes for Emergency Medical CRITs with Simultaneous TROUTs

Code	Call Type Text	Count
10C	EMERGENT CHEST PAIN	8
10D	EMERGENT CHEST PAIN	15
11D	EMERGENT CHOKING	2
12C	EMERGENT CONVULSIONS	19
12D	EMERGENT CONVULSIONS	12
13C	EMERGENT DIABETIC	5
13D	EMERGENT DIABETIC	2
14D	EMERGENT DROWNING /	1
15D	EMERGENT ELECTROCUTI	1
17D	EMERGENT FALLS	17
18C	EMERGENT HEADACHE	6
19C	EMERGENT HEART PROBL	3
19D	EMERGENT HEART PROBL	12
1C	EMERGENT ABDOMINAL P	5
1D	EMERGENT ABDOMINAL P	3
20D	EMERGENT EXPOSURE	1
21D	EMERGENT HEMORRHAGE	5
23C	EMERGENT OD/POISON	6
23D	EMERGENT OD/POISON	1
24D	EMERGENT PREGNANCY/B	1
25D	EMERGENT PSYCHIATRIC	3
26C	EMERGENT SICK	17
26D	EMERGENT SICK	8
28C	EMERGENT STROKE	14
2C	EMERGENT ALLERGIES	5
2D	EMERGENT ALLERGIES	5
30D	EMERGENT TRAUMATIC I	1
31C	EMERGENT UNC/FAINT	14
31D	EMERGENT UNC/FAINT	32
32D	EMERGENT UNKNOWN PRO	4
5D	EMERGENT BACK PAIN	2
6C	EMERGENT BREATHING P	14
6D	EMERGENT BREATHING P	36
9D	EMERGENT CARDIAC	2
ECHOB	EMERGENT BREATHING P	1
ECHOC	ECHO CARDIAC	13
EMVA	EMERGENT MOTOR VEHIC	111
MEDIC	MEDIC	319
TERA2	CRITICAL CARE TRANSP	39
TRANS1	LEVEL 1 TRANSPORT	14
TRANS2	LEVEL 2 TRANSPORT	234
TRANSF	IN COUNTY TRANSFER F	132
TRANSO	IN COUNTY TRANSFER F	49
		1194

Figure 29. CallType Codes for Fire Related CRITs with Simultaneous TROUTs

Code	Call Type Text	Count
ALARMC	CO ALARM RESPONSE	50
ALMCO	COMMERCIAL FIRE ALAR	141
ALMRES	RESIDENTIAL FIRE ALA	133
ELVTR	ELEVATOR PROBLEM, NO	3
ELVTRP	ELEVATOR ALARM/PROBL	17
FASSIM	FD ASSIST TO OTHER A	14
FASSIP	FIRE PUBLIC ASSIST	23
FIRED	DUMPSTER FIRE	5
FIRES1	FIRST ALARM STRUCTUR	15
FIREV	VEHICLE FIRE	28
FIREW	WILDLAND FIRE	10
FIREW2	SECOND ALARM WILDLAN	3
GASLK	NATURAL GAS/PROPANE	12
GASOD	NATURAL GAS/PROPANE	53
HAZCH	HAZARDOUS CHEMICAL M	1
HAZMAT	HAZMAT INCIDENT	6
POWER	POWER LINES DOWNS	6
RESCUE	RESCUE FROM TRAPPED	1
SMESM	SMELL OF BURNING/SMO	25
SMOKE	OUTDOOR SMOKE SIGHTI	22
SPILL	COMMON FLAMMABLE LIQ	13
SPRNKC	SPRINKLER WATER FLOW	20
SPRNKR	SPRINKLER WATER FLOW	1
SWIFT	SWIFT WATER RESCUE C	5
		607

ATTACHMENT F

Calculation of t-Values and Correlations to p-Values

Attachment F.

Calculation of t-Values and Correlations to p-Values

A statistically significant result of a t-test is one in which a difference between two groups is unlikely to have occurred because the samples happened to be atypical. Statistical significance is determined by the magnitude of the difference between the group averages, by the number of instances in each group, and the standard deviation (variance) within each group.

The formula used to calculate the t-test is a ratio. The top portion of the ratio is the easiest to understand, as it is simply the difference between the averages of the two groups. The bottom portion of the ratio is known as the standard error of the difference. To calculate this part of the ratio, the variance for each of the two groups is determined and is then divided by number of instances that comprise each group. These two values are added together, and a square root is taken of the result.

The analysis required in this project is specifically the Welch t-Test which compares two groups with unequal averages and unequal standard deviations (variances).

Welch's t-Value Equation for Unequal Populations with Unequal Variances

N_1 = Number of samples in distribution 1
$\overline{X}_1$ = Mean of distribution 1
σ_1 = Standard deviation of distribution 1

N_2 = Number of samples in distribution 2
$\overline{X}_2$ = Mean of distribution 2
σ_2 = Standard deviation of distribution 2

Z = Degrees of Freedom (Welch-Satterwaite equation)

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}$$

Degrees of Freedom for Unequal Populations with Unequal Variances

Z = Degrees of Freedom (Welch-Satterwaite Equation)

$$Z = \frac{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)^2 (N_1 - 1)(N_2 - 1)}{\left(\frac{\sigma_1^2}{N_1}\right)^2 (N_1 - 1) + \left(\frac{\sigma_2^2}{N_2}\right)^2 (N_2 - 1)}$$

Figure 30 Correlation of t-Values to p-Values for Varying Degrees of Freedom

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	**50%**	**60%**	**70%**	**80%**	**90%**	**95%**	**98%**	**99%**	**99.8%**	**99.9%**
					Confidence Level						

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