The Availability of Prior ECGs Improves Paramedic Accuracy in Identifying STEMIs

Daniel O'Donnell, MD, Mike Mancera, MD, Eric Savory, MD, Shawn Christopher EMT-P, Steve Roumpf, MD, Jason Schafer, MD Indiana University School of Medicine, Indianapolis Indiana

Clinical Question

Does the availability of previous ECGs improve paramedic accuracy in ECG interpretation?

BACKGROUND

- Prehospital ECGs are a vital component of the initial evaluation and management of chest pain patients.
- Early identification of STEMIs by paramedics has been shown to improve door to balloon times.
- While paramedics' accuracy is good, there is still room for improvement.
- Utilization of prior ECGs for comparison is commonplace in the Emergency Department.

Materials and Methods

- Randomized crossover trial of 130 paramedics
- ECG test bank generated from large Hospital-based STEMI registry
- 12 item test with standardized patient scenario
- 6 ECGs diagnostic ECGs; 6 diagnostic ECGs with prior for comparison
- All ECGs randomly assigned
- Asked to decide to activate a STEMI alert and rate confidence in decision
- Answers scored against gold standard

Previous EKG improves interpretation

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<th>OR</th>
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<th>P-value</th>
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Subject Characteristics and Accuracy

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<td>(0.65, 1.33)</td>
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<tr>
<td>12 lead training in med school (No vs. Yes)</td>
<td>0.95</td>
<td>(0.66, 1.49)</td>
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Subject Characteristics

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<td>7.5</td>
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<td>Mean hours worked per month</td>
<td>70.7 (h)</td>
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SUMMARY

- The availability of prior ECGs improves paramedic accuracy in interpreting ECGs.
- The addition of Prior ECGs also improves paramedic confidence in his/her interpretation.
- Increase integration of Electronic Medical Records could lead to improved paramedic performance.
- Age, years serving as a paramedic, and routine use of prior 12 lead ECGs were not associated with increased accuracy.

CONCLUSIONS

- The availability of prior ECGs improves paramedic accuracy in 12 lead ECG interpretation.
- Additional studies are needed to investigate their role in clinical practice.
Impact of EMS Prehospital Activation of Cardiac Catheterization Lab on Door to Balloon and EMS to Balloon Time

Ryan Hartman MD, Francis Mencl MD MS, Jennifer Frey PhD, Mary Colleen Bhalla MD, and Scott Wilber MD MPH
Summa Akron City Hospital, Akron, OH

Main points:

**Background**
- Timely restoration of blood flow in an occluded coronary artery is crucial to decreasing morbidity/mortality in STEMI.
- At Summa Akron City Hospital (ACH), all EMS squads transporting to ACH have the ability to acquire and transmit ECGs to the ED for physician interpretation and pre-arrival catheterization (cath) lab activation.
- >80% of STEMI's arrive by EMS.
- >60% of STEMI's arrive outside of the cath lab operating hours (0730-1700 Mon-Fri) when early notification is essential.
- 55% of STEMIs are inferior MIs which prior studies have shown are well recognized by our medics.
- Beginning in January 2012, select EMS squads began to activate the cath lab directly from the field if the ECG was diagnostic of STEMI and if it met the criteria of:
  - A clear tracing
  - Interpreted as a STEMI by the ECG machine
  - Recognized as a STEMI by the medic
- ECGs were still transmitted to the ED and the ED physician has final say and responsibility for the cath lab activation.

**Methods**
- A retrospective review of the Summa ACH STEMI database from 2011 and 2012 was performed.
- Data Collected:
  - Time of EMS Arrival to Patient
  - Time of Patient Arrival to Hospital
  - EMS to Balloon Time
- Key Outcome Measurement:
  - Door-to-Balloon Time (D2B)
  - EMS-to-Balloon Time (E2B)
- Data Analysis:
  - Mean times with a 95% confidence interval was performed.
  - Two sample t tests were performed, significance was p ≤ 0.05.

**Results**
- Prehospital activation of the cath lab lead to a significant decrease in D2B/E2B times of ~11 minutes.
- This may lead to improved outcomes in STEMI.

**Limitations**
- The data represent one institution only.
- This was a quality measure study of a STEMI database and patient outcomes were not followed.
- The actual EMS on scene arrival times were not always recorded and the time of first vital sign measurement was used in these cases.

**Conclusions**
- Prehospital activation of the cath lab lead to a significant decrease in D2B/E2B times of ~11 minutes.
- This may lead to improved outcomes in STEMI.
Effects of Prehospital ECG Use and Patient Home Distance from PCI Center on Time to Device Activation in STEMI: A Report from the ACTION Registry® - GWTG™

Bryn Mumma, MD, MASa; Michael C. Kontos, MDb; S. Andrew Peng, MSb; Deborah Diercks, MDb; a Department of Emergency Medicine, University of California Davis, Sacramento, CA; b Division of Cardiology, Virginia Commonwealth University Medical Center, Richmond, VA; c Duke Clinical Research Institute, Durham, NC; on behalf of the NCDR

Background

- Longer time to reperfusion in STEMI is associated with increased morbidity and mortality
- AHA goal of 90 minutes from first medical contact to reperfusion (FMC2B) is often not achieved
- Prehospital electrocardiograms (ECGs) reduce FMC2B
- Relative influence of the patient’s distance from the PCI center on the effect of prehospital ECGs is unknown

Hypothesis

Prehospital ECGs will be associated with shorter FMC2B time, an effect that will increase with longer patient home distance from the PCI center.

Methods

- Retrospective cohort study including all STEMI patients in the ACTION Registry-Get With the Guidelines from 7/1/2008 to 9/30/2012 who were transported by ground EMS to a PCI center for primary PCI
- Patient home distance defined as the driving distance from the patient’s home zip code to the PCI center address
- Patient home distance was classified into tertiles (<7.1 miles, 7.1-16.3 miles, >16.3 miles)
- Linear regression to characterize the interaction between prehospital ECG use and patient distance with respect to FMC2B time.

Results

- Of the 29,506 STEMI patients, 19,690 (67%) received a prehospital ECG.
- Median patient home distance to the PCI center was 11.0 miles among patients with and 9.9 miles among those without a prehospital ECG.
- Prehospital ECGs were associated with a 10-minute reduction in the FMC2B time (p<0.0001), which was consistent across distance tertiles.
- The association between prehospital ECGs and shorter FMC2B was attenuated by 0.8 minutes for every 10 mile increase in distance (interaction p=0.0002).

Limitations

- Patient home zip code vs. EMS call location
- Unknown timing of cardiac catheterization lab activation
- Unable to ascertain causality
- Heterogeneity in prehospital and hospital processes

Conclusion

- Prehospital ECGs are associated with a 10-minute reduction in time from FMC to device activation
- Patient home distance from a PCI center does not substantially change this association, but presentation during off hours was associated with longer times.

| Baseline Characteristics | Outcomes by Patient Home Distance and ECG |

| Age (years) | 60 (55-65) | 60 (55-71) | 60 (55-71) |
| Male gender | 14,151 (77.9%) | 6,772 (88.8%) | 6,772 (88.8%) |
| Race/Ethnicity | White 16,541 (84.0%) | 7,995 (81.5%) | 7,995 (81.5%) |
| Hispanic 917 (4.6%) | 417 (5.4%) | 417 (5.4%) |
| Other/Missing | 873 (4.5%) | 428 (4.5%) | 428 (4.5%) |
| Prehospital ECG (N=19,960) | No Prehospital ECG (N=9,816) | Overall 84 (66-95) | 84 (67-96) | 86 (71-103) | <0.0001 |
| 1st Tertile | 9,876 | 6,732 (68.6%) | 9,995 (81.5%) | 9,867 (52.15%) | 9,995 (81.5%) | 9,995 (81.5%) | <0.0001 |
| 2nd Tertile | 7,164 | 6,732 (68.6%) | 7,995 (81.5%) | 7,164 (52.15%) | 7,995 (81.5%) | 7,995 (81.5%) | <0.0001 |
| 3rd Tertile | 2,920 | 6,732 (68.6%) | 7,995 (81.5%) | 2,920 (52.15%) | 7,995 (81.5%) | 7,995 (81.5%) | <0.0001 |

| Time Intervals by Patient Home Distance and Prehospital ECG |

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<th>3rd Tertile - ECG</th>
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<tr>
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<td>23 (17-29)</td>
<td>22 (17-29)</td>
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<tr>
<td>FMC to hospital arrival</td>
<td>26 (21-33)</td>
<td>30 (24-37)</td>
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<tr>
<td>CCL arrival to device</td>
<td>27 (20-34)</td>
<td>30 (23-45)</td>
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<td>MI=Myocardial infarction</td>
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This research was supported by the American College of Cardiology Foundation’s National Cardiovascular Data Registry (NCDR). The views expressed in this abstract represent those of the author(s), and do not necessarily represent the official view of the NCDR or its associated professional societies identified at www.ncdr.com.

For more information go to: www.ncdr.com or email ncdrresearch@acc.org
Novel Application of 9-1-1 Dispatch in STEMI Alert Process Decreases Door to Ballon Times (DTB.)
Justin Stowens, MD, Seema Sonad, PhD, Robert Rosenbaum, MD FACEP
Christiana Care Health System, Newark, DE. Special Thanks to New Castle County EMS

DISCLOSURES:
No Authors have any financial or bias disclosures to report.

INTRODUCTION
Many hospital systems have incorporated EMS directed activation of the cardiac catheterization lab (CCL) for STEMI patients.

- Use of Paramedic CCL activation decreases DTB without significant improper activations as shown in prior studies.
- The focus on streamlining this process has remained largely centered on in-hospital variables.
- There may be further untapped resources to streamline the process of CCL activation in such a way to further decrease DTB.

STUDY OBJECTIVES
We sought to determine the potential reduction in DTB by allowing paramedics to perform pre-hospital STEMI notification by brief communications (one sentence with age, gender, “STEMI” and ETA) through EMS 9-1-1 dispatchers who directed the request to the hospital.

This allowed earlier CCL activation even when on-scene variables precluded conversation with medical control.

Setting
- 913-bed, Level 1 trauma center, located in Newark, DE.
- The only hospital with Level 1 designation and CCL capabilities between Baltimore and Philadelphia.
- > 120,000 ED patients per year.
- County sponsored ALS transport, BLS trained fire department response, and hospital based critical care transport.
- Between 400 and 500 STEMI on average per year from EMS.

Methods
- Retrospective Chart Review of 1405 STEMI notifications between 7/2010 - 7/2012
- Creation of a control and study group by paramedic decision to utilize either a dispatch aided alert process or the standard, direct to physician alert method.
- Statistical analysis of the difference in the average DTB between the study group and the control group. See figure 2.

RESULTS
- The average DTB for the standard communication method was 57.6 minutes (SD 4.5). (See figure 1)
- The average DTB for the dispatcher aided method was 46.1 minutes (SD 3.2.) (See figure 1)
- The difference in DTB between the two groups was an average of 11.5 minutes (p=.001.)
- In the Dispatcher aided group 92% (59/64) met < 90 minute DTB. (p <.001)
- Only 64% (41/64) met this goal in the standard communication group (p <.001.)
- Control and study groups had no statistical difference in CAD risk and co-morbidities.

LIMITATIONS
- Despite reassuring analysis of patient characteristics, there may have been unaccounted for selection bias during the paramedic driven group allocation.
- Rates of improper activation of the CCL have not yet been examined and may hold implication for future implementation.
- Study of single hospital and single County EMS agency

CONCLUSIONS
- In systems that utilize prehospital CCL activation for STEMI patients, utilization of 9-1-1 Dispatchers in STEMI activation is a cost-free option for decreasing DTB.
A Characterization of Code STEMI Activations by Patient’s Presenting Location
Jonathan Studnek PhD, NRP; Chrystan Skefos MD; Allison Infinger MSPH; Lee Garvey MD

Introduction
• Early identification of patients presenting to Emergency Medical Services (EMS) with an ST elevation myocardial infarction (STEMI) has been shown to decrease time to definitive treatment.
• A further understanding of the characteristics of patient’s presenting to EMS with STEMI may assist in the development of care processes that improve either recognition or expedite delivery of patients to appropriate facilities.

Objective
The objective of this study was to identify characteristics of prehospital STEMI patients that vary by a patient’s presenting location.

Methods
• This was a retrospective study of STEMI patients presenting to one of three PCI centers transported by a single EMS agency between May 2007 and March 2011.
• Data for this analysis were obtained from EMS patient care report forms and emergency department medical records. This study was approved by both the Carolinas Medical Center and Presbyterian Healthcare Institutional Review Boards.
• Patients were classified by EMS as presenting at either home or some other public location.
• Other patient characteristics assessed included the day of the week and time of day of presentation, gender, race, and number of comorbidities.
• False positive STEMI activations were excluded from this analysis.
• Descriptive statistics were calculated with chi-squared analysis used to assess for significant associations.

Results
• There were 238 patients included in this analysis, of which 71.8% were found by EMS at a location classified as home.
• Time of day and race were the two characteristics of patients that varied by the patients presenting location. 77.7% of patients presenting to EMS at a location other than home did so between the hours of 06:00 and 18:00 with only 53.0% of patients presenting at home during the same hours (p=0.01). Further, there was a significant association between a patients race and their presenting location (p=0.023).

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*p<0.05

Conclusion
• This study indicated that a clear majority of prehospital STEMI patients presented to EMS in the home.
• Results from this study may further justify educating family members regarding signs and symptoms, and the importance of early EMS activation to help reduce morbidity and mortality.

Limitations
• This was a hypothesis generating study using retrospective data obtained through chart abstraction.
• The exposure variable of inters (location type) was a crude measure. Further efforts may use a more sophisticated exposure assessment method (GIS) to assess whether these associations remain valid.

Acknowledgements
The authors would like to thank the Mecklenburg EMS Agency, Carolinas HealthCare System, and Presbyterian Health care for supporting this project.

The Mecklenburg EMS Agency is a joint agency of Mecklenburg County, Carolinas HealthCare System and Novant Health.
Prevalence of Prehospital Electrocardiograph ST-elevation Myocardial Infarction Mimics

Mary C. Bhalla MD1, Jennifer A. Frey PhD1, Jennifer Yee DO1, William Hardy BS2, Christopher Myers DO1, Francis Mencl MS MD1

1Summa Akron City Hospital, Akron OH, 2Northeast Ohio Medical University, Rootstown, OH

Introduction

• Emergency Medical Services (EMS) are a vital component for prehospital evaluation and assessment of potential manifestations of an acute coronary syndrome.

• Definitive treatment of ST-elevation myocardial infarctions (STEMI) is reperfusion therapy.

• Decreasing time to reperfusion decreases morbidity and mortality.

• Achieved by accurate and efficient EMS electrocardiogram (ECG) interpretation.

• Such a task may be impeded by ECG rhythms that mimic STEMI

  • Right bundle branch blocks (RBBB)
  • Left bundle branch blocks (LBBB)
  • Left ventricular hypertrophy (LVH)
  • Supraventricular tachycardia (SVT)
  • Pacemaker-driven rhythms (VP)

• Distinguishing between these rhythms is dependent on provider interpretation and training.

Objectives

• To evaluate the prevalence of prehospital ECG STEMI mimics

• Make recommendations regarding educating EMS providers on ECG interpretation

Materials and Methods

• Setting:
  • Community-based university-affiliated emergency department (ED)
  • Level 1 trauma center
  • 78,000 adult patient visits per year
  • Staffed by emergency medicine residents and faculty
  • Cardiac catheterization team on call 17:30 – 07:00 weekdays and on weekends
  • EMS providers acquire ECGs with LifePak 12 monitor/defibrillators and transmit en route to the ED.

• The ECGs are stored in the receiving station database LifeNet (Medtronic, Inc. Minneapolis, Minnesota USA).

• More than 20 different EMS providers transported about 17,000 patients to the ED per year.

• Study Population:
  • 800 ECGs randomly selected from 4979 ECGs in the 2012 database.

• Included for analysis the first 600 that were not determined to be unreadable secondary to missing data in one or more leads.

• Data Collection
  • ECGs were examined separately by two emergency medicine physicians for the presence of STEMI, STEMI mimics, or No STEMI/STEMI mimics using rigid diagnostic criteria.
  • Any disagreement between interpreters was settled by a third physician interpreter.

• Sample size
  • Predetermined to be 600 ECGs in order to have a 95% Confidence Interval (CI) of +/- 4%.

Example ECGs

Results

• 800 ECGs randomly selected
  • Seven were removed because they were duplicates
  • 19 were unreadable (2.4%, 19/793, CI 1.4-3.7%)

• 600 ECGs interpreted (Figure 2)
  • 4.2% STEMI (25/600, CI 2.7-6.1%)
  • 26% STEMI mimic (155/600, CI 22.4-29.5%)
  • 7.5% RBBB (45/600, CI 5.5-9.9%)
  • 4.7% LBBB (28/600, CI 3.1-6.7%)
  • 8.0% LVH (48/600, CI 6.0-10.5%)
  • 2.2% SVT (13/600, CI 1.2-3.7%)
  • 3.5% VP (21/600, CI 2.2-5.3%)

Conclusions

• In our study population EMS providers were more likely to see STEMI mimics than they were to see STEMs.

• For our EMS providers to be well trained in STEMI identification they must be taught STEMI mimics as well.

SUMMA AKRON CITY HOSPITAL
Systematic review and meta-analysis of the benefits of prehospital 12-lead ECG and advanced notification in STEMI patients

Julian Nam MSc, Kyla Caners MD, James M Bowen MSc, Michelle Welsford MD ABEM FRCP(C), Daria O’Reilly MSc PhD

Intro
- Pre-hospital 12-lead ECG (PHTL) Class I recommendation by AHA
- Previous reviews evaluated door-to-reperfusion time, ignoring EMS time
- Goal: updated review of STEMI patients transported by EMS with 12-lead ECG and advanced notification vs no monitoring

Methods
- Embase, PubMed, Cochrane library search for RCTs & observational studies
- Followed PRISMA, 2 abstractors
- Outcomes:
  - Short-term mortality (<30 days)
  - Door-to-balloon/needle time
  - First-medical-contact (FMC) to balloon/needle time
- Excluded if pre-hospital fibrinolysis or walk-in patients

Results
- 1857 citations narrowed to 68 full texts
- 16 studies included (15 percutaneous coronary intervention, 3 thrombolysis, 2 both); no RCTs
- 12-lead ECG + advanced notification led to:
  - 39% mortality reduction in PCI patients (RR 0.61, 95%CI 0.42-0.89, p=0.01)
  - 29% mortality reduction in thrombolysis patients (RR 0.71, 95%CI 0.54-0.93, p=0.01)

Discussion
- Largest review completed
- Few included studies reported short-term mortality or first-medical-contact-to-reperfusion times
- Significant heterogeneity between studies
- Observational studies limit quality of evidence

Conclusion
- Pre-hospital 12-lead ECG + advanced notification:
  - Reduces short-term mortality
  - Decreases first-medical-contact to reperfusion time
  - Decreases door to reperfusion time

<table>
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<th>Study or Subgroup</th>
<th>Mean Difference</th>
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<td>Nestler</td>
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<td>Chan</td>
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<tr>
<td>Total (95% CI)</td>
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*Only 7/15 PCI studies reported FMC to balloon time
### Background

- Chest pain warrants a rapid assessment, including an early 12-lead ECG.
- Rapid identification of ST elevation myocardial infarctions (STEMIs) or new left bundle branch blocks is of critical importance.
- Established guidelines emphasize the importance of early STEMI identification and minimization of door-to-balloon (DTB) times.
- Prehospital identification of STEMI may result in earlier cardiac catheterization lab (CCL) activation.
- However, meeting first ECG-to-CCL activation time guidelines may be challenging for the emergency department (ED) to comply with when using prehospital ECGs.

### Objectives

- To study the timeliness of prehospital ECG arrival for review by ED physicians to identify potential delays.
- Such delays may be inappropriately attributed to the ED when assessing compliance of the first ECG-to-CCL activation time of <5 minutes recommended by the Society of Chest Pain Centers (SCPC).

### Methods

- **Design:** Retrospective observational convenience sample.
- **Setting:** Urban tertiary academic hospital.
- **Data set:** All prehospital ECGs transmitted by 13 EMS agencies through LifeNet Systems™ from January 1, 2013, through June 30, 2013.
- **Protocol:** ECGs were reviewed for times obtained and received. The time difference for each ECG was calculated (i.e., obtained to received time (OTRT)). The mean and median OTRTs were found. Average OTRTs were calculated for each agency.

### Results

- 1700 ECGs.
- 35 with incomplete data.
- 1 removed for being an extreme outlier (OTRT 22 hours 58 minutes 51 seconds).
- 1664 ECGs with complete data.
- Mean OTRT: 5 minutes 54 seconds.
- Median OTRT: 3 minutes 23 seconds.
- Minimum OTRT: 14 seconds.
- Maximum OTRT: 8 hours 56 minutes 28 seconds.
- 11 of the 13 agencies had average OTRTs of no more than 8 minutes 14 seconds.
- Potential causes for prolonged OTRTs include:
  - EMS delay in initiating ECG transmission.
  - Network delays in processing.
  - Incorrect times due to lack of time synchronization.
  - Delay in recognition of ECG arrival in the ED.

### Conclusion

- Printed prehospital ECG times do not accurately reflect the time information becomes available to the ED physician and should not be used as a benchmark for first ECG-to-CCL activation times.
- Further research should investigate these time delays and focus on methods to reduce transmission delays.
The Environmental Impact of the EMS Supply Chain

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Conflicts of Interest: The authors declare no conflicts of interest.

Purpose:
- Estimate the life cycle emissions of U.S. EMS systems, including emissions from supply chain processes.
- Determine the components of the EMS supply chain that contribute most to those emissions.

Data Sources:
- Publicly available EMS budget information for the two most recent budget years of nine EMS systems in a randomly selected list of 200 cities and counties.

Primary Analysis:
- Consumer price index used to convert expenditures to standard year (2002) amounts.
- All expenditures mapped to one of 46 economic sectors.
- US government sector-specific emissions multipliers then used to calculate “indirect emissions” related to each purchased product or service.
- Volume of diesel, gasoline and natural gas consumed by each system estimated (amount spent ÷ average price), and volume-based emissions multipliers were used to calculate “direct emissions” from energy consumption.
- “Indirect” and “direct” emissions summed to calculate life cycle emissions.

Secondary Analyses:
- "Retail trade" multiplier used for vehicle fuel and heating oil expenditures.
- "Retail trade" multiplier used for all purchases in all economic sectors.
- "Healthcare and social assistance" multiplier used for all EMS system expenditures.

Results:
- Nine EMS systems located in seven states: population: 7,500 to 400,000; response volume: 1,200 to 90,000; expenditures: $290 ± 128 per response
- Data for 16 total budget years: $94.7 million (in 2002 dollars) in expenditures; 21,877 t of carbon dioxide equivalent (CO2e) emissions generated

231 t CO2e per $1 million of expenditure

Estimated U.S. Total: 3 million t CO2e annually (95%CI: 2.3 to 3.6 million t CO2e)

Non-energy supply chain = 25% of EMS-related life cycle emissions

Implication:
- Reducing waste in the EMS supply chain could have dual benefits of reducing system operational costs and reducing greenhouse gas emissions.

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