Cardiac Outcomes in US First Class Airmen Who Underwent a Stent or CABG Procedure

Introduction

- Current literature reports a 10-20% event recurrence (repeat stent, death, MI, CABG after initial stent) after initial cardiac revascularization in the general population.
- Although previous studies have determined the effectiveness of drug-eluting stents (DES) compared with bare-metal stents (BMS) in specific population subsets, methodological issues such as inconsistent or incomplete follow-up times for comparison groups exist.
- No studies have closely examined revascularization events in US civilian airman.
- This study sought to determine outcome trends in revascularization events among first-class medically-certified airmen who underwent surgery for a stent or CABG.

Methods

- All first class airmen who had an exam and had an initial stent or CABG performed between 2005 and 2012.
- All records were individually reviewed to determine date of procedure, medical certification status, and potential adverse or recurrent events.
- Each airmen was followed from the date of procedure through December 31, 2015. If the airmen dropped out of the system before this date, their last exam date in the medical certification database was recorded.
- Variables collected included age at initial procedure, number of vessels treated, type of procedure, type of stent, gender, BMI, history of diabetes, history of hypertension, vascular disease, family history of coronary artery disease, esophagectomy pre and post catherization, LDL pre and post catherization, cholesterol pre and post catherization, smoking and alcohol history, medication use, and the cardiac revascularization outcomes of interest.
- Major adverse cardiac events were defined as:
  - Death
  - MI
  - Repeat revascularization
- Survival analysis for these major adverse cardiac events was performed comparing the following groups:
  - BMS vs DES
  - All stents vs CABG

Survival Curves of BMS vs DES

- Of the 417 airmen who received a stent, 89 (21.3%) were noted as having a major adverse cardiac outcome after their initial stent.
- The rate of events is not statistically different between those who had a BMS vs those who had a DES, 25.8% vs 20.9% respectively (p=0.4738).
- 163 (39.1%) were lost to follow-up over the first 5 years of the study period.

Survival Curves of Stents vs CABG

- Of the 564 airmen undergoing either a CABG or stent, 114 (20.2%) were noted as having a major adverse cardiac outcome after their initial stent or CABG.
- The event rate is not statistically different between those who had a stent vs those who had a CABG, 21.3% vs 17% (p=0.283).
- 213 (38.6%) were lost to follow-up over the first five years.
- While CABG patients appear to be in worse health before treatment, they appear to achieve the same level of outcomes from treatment as the stent group.

Results

Airmen Undergoing CABG vs Stent

- The average time to first recurrence was approximately 1 year for both stents and CABG.
- The survivorship status is defined as the number of airmen who are still in the medical certification system with a valid medical certificate and not having experienced a recurrent outcome.

<table>
<thead>
<tr>
<th>Variable</th>
<th>BMS vs DES</th>
<th>CABG vs DES</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>43.2 (6.0)</td>
<td>46.0 (6.1)</td>
<td>0.008</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>27.1 (4.6)</td>
<td>28.0 (4.8)</td>
<td>0.154</td>
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<tr>
<td>Vascular disease (%)</td>
<td>10.7 (0.0)</td>
<td>15.0 (0.0)</td>
<td>0.009</td>
</tr>
<tr>
<td>CABG (%)</td>
<td>1.6 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
| Time to First Recurrence and Survivorship

- The average time to first recurrence was approximately 1 year for both stents and CABG.
- The survivorship status is defined as the number of airmen who are still in the medical certification system with a valid medical certificate and not having experienced a recurrent outcome.

<table>
<thead>
<tr>
<th>Time to First Recurrence Percentile in Years</th>
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<tbody>
<tr>
<td>75%</td>
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</tbody>
</table>

Discussion

- **Time to recurrence**:
  - If we only look at those 8 airmen who had an MI, these events occurred over 1.4 years after initial procedure with 8% occurring within 8.8 months.
  - This rate is similar to the average of the 6 month waiting period after the stent or CABG procedure before the airmen return to flying.
  - Our results demonstrate it may be appropriate to move the waiting period to the 80% timeframe.
  - To some extent, time to recurrence is driven by time to repeat angiogram, given that many airmen with recurrence are not symptomatic when a problem is detected by angiogram.
  - This increases recurrence frequency and drives the time to recurrence observed in this study. A waiting period change may not have any impact.
  - Additionally, most recurrences are repeated treatment and MIIs appear rare.
  - All airmen who had a recurrent event were further reviewed to determine if they had a valid medical at the time of the event.
  - Of the 113 airmen with a recurrent event, only 16 (14%) had a valid medical at the time of the event:
    - 3 of these 16 were MIIs
    - Many of the airmen had a recent medical before the recurrent event but were in a deferred status at the time of the event. Others had been denied or were in a failure to provide status.
- **Rates of revascularization**:
  - While our revascularization rates are similar to the other published studies, our population is younger and overall healthier (at least on paper) than those in the other studies. In a study published in 2007 (Abbot et al.), the average age was 64, 28-54% with diabetes and 74-89% with hypertension compared to our study with an average age of 66, 7% with diabetes and 37% with hypertension.
  - Also, in the Abbott study 17-18% had a prior coronary bypass where in our study we were focusing on the initial stent or CABG. With this in mind, our revascularization rate would most likely be higher than indicated if our population was more comparable to those in previous studies. However, this could be explained by the angiograms that are required before airmen can return to fly as they are required regardless if the airmen is symptomatic or not. By policy, we may provoke more re-treatment than would be observed by relying on airmen presentation of symptoms alone.

Limitations

- The number of airmen being lost to follow-up.
  - In the first year, we lose 15%, increasing to 2% in years 2 and 3%
  - In years 4 and 5, 15% of the general population would be lost.
  - Due to the nature of the way we follow our airmen, it is unlikely that we will capture a death due to any reason other than an aircraft accident. Thus if death occurs they will drop out of the system and be lost to follow-up the same as if the airmen chose to no longer renew their medical certificate. In the same manner, if an airmen suffers a severe adverse event or returns for a future exam and we will not capture their MIIs either. It is difficult to determine the impact that this would have on the adverse rates for our studies as we have no way to determine why an airmen does not return for a follow-up exam.
  - There is a lot of missing data on baseline variables before the procedure.
  - Despite these limitations, this study demonstrates that more studies assessing risk in aerospace medicine should be implemented.