



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

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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 airmen.
- This study sought to determine outcome trends in revascularization events among first-class medically-certificated airmen who underwent surgery for a stent or CABG.

Methods

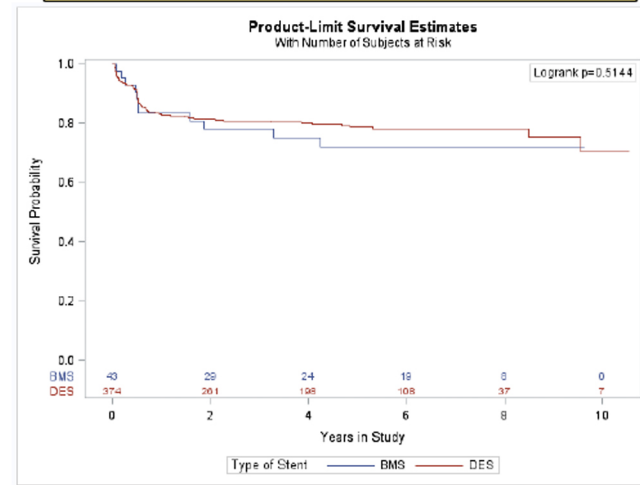
- All first class airmen who had an exam and had an initial stent or CABG performed between 2005 and 2012.
- All records were individually reviewed to determine date of procedure, medical certification status, and potential adverse or recurrent events.
- Each airman was followed from the date of procedure 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, valvular disease, family history of coronary artery disease, ejection fraction pre and post catheterization, LDL pre and post catheterization, cholesterol pre and post catheterization, 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

Results

Airmen Undergoing Stents

Variable	BMS (n=43)	DES (n=374)	p-value
Age, mean (std)	54.0 (7.7)	54.2 (6.7)	0.6982
Female (%)	0 (0.0)	1 (0.3)	1.0000
BMI, mean (std)	27.9 (3.7)	28.4 (3.7)	0.2958
Diabetes (%)	4 (9.3)	26 (7.0)	0.1911
Hypertension (%)	14 (32.6)	125 (33.7)	0.8814
Valvular disease (%)	0 (0.0)	12 (4.2)	0.3735
Family history of CAD (%)	23 (56.1)	189 (53.9)	0.7843
Ejection fraction pre-cath, mean (std)	55.6 (9.0)	55.3 (9.4)	0.9636
Ejection fraction post-cath, mean (std)	58.7 (8.7)	59.7 (8.6)	0.4844
LDL pre-cath, mean (std)	120.8 (32.0)	114.7 (38.5)	0.5616
LDL post-cath, mean (std)	74.2 (27.0)	75.1 (27.0)	0.3835
Cholesterol pre-cath, mean (std)	181.5 (39.3)	188.6 (42.5)	0.5458
Cholesterol post-cath, mean (std)	144.7 (38.1)	141.2 (32.6)	0.6771
Current smoking (%)	10 (23.8)	98 (27.4)	0.6225
Alcohol pre-cath (%)	16 (40.0)	141 (47.2)	0.3939
Alcohol post-cath (%)	15 (42.9)	126 (42.3)	0.9480
Vessel disease (%)			
1	38 (90.5)	267 (72.0)	
2	3 (7.1)	77 (20.8)	0.0352
3 or 4	1 (2.4)	27 (7.3)	
Beta blocker (%)	39 (90.7)	288 (77.0)	0.0387
Ace inhibitor (%)	26 (60.5)	203 (54.3)	0.4400
Plavix (%)	38 (88.4)	363 (97.1)	0.0170
Statin (%)	43 (100.0)	372 (99.5)	1.0000
Aspirin (%)	43 (100.0)	367 (98.1)	1.0000

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.

Type of Event	BMS (n=43)	DES (n=374)
Repeat stent (%)	9 (20.9)	68 (18.2)
CABG following initial stent (%)	1 (2.3)	5 (1.3)
MI (%)	1 (2.3)	5 (1.3)

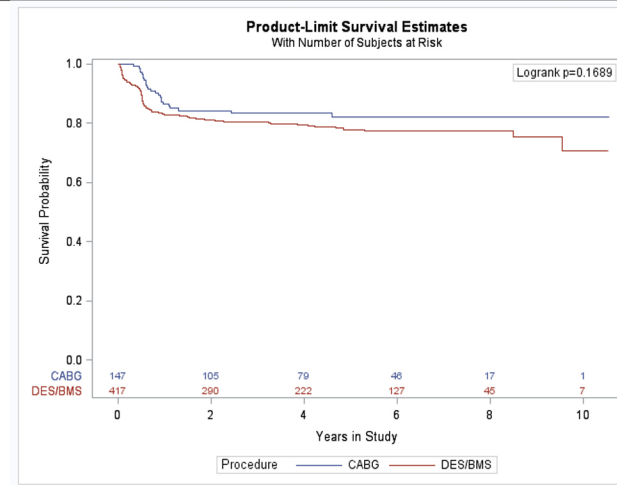
• The rate of events is not statistically different between those who had a BMS vs those who had a DES, 25.6% vs 20.9% respectively (p=0.4738).

• 163 (39.1%) were lost to follow-up over the first 5 years of the study period.

Airmen Undergoing CABG vs Stent

Variable	BMS/DES (n=417)	CABG (n=147)	p-value
Age, mean (std)	54.2 (6.8)	55.5 (6.6)	0.0291
Female (%)	1 (0.2)	0 (0.0)	1.0000
BMI, mean (std)	28.4 (3.7)	29.2 (14.4)	0.3160
Diabetes (%)	30 (7.3)	8 (5.6)	0.4878
Hypertension (%)	139 (33.6)	69 (47.6)	0.0027
Valvular disease (%)	12 (3.7)	25 (19.8)	<0.0001
Family history of CAD (%)	180 (45.9)	52 (37.7)	0.0935
Ejection fraction pre-cath, mean (std)	55.3 (9.4)	55.1 (10.2)	0.9839
Ejection fraction post-cath, mean (std)	59.6 (8.6)	57.9 (8.6)	0.0738
LDL pre-cath, mean (std)	115.2 (37.9)	130.7 (59.9)	0.1472
LDL post-cath, mean (std)	75.0 (27.0)	82.0 (26.3)	0.0011
Cholesterol pre-cath, mean (std)	188.1 (42.2)	209.7 (65.1)	0.0637
Cholesterol post-cath, mean (std)	141.5 (33.1)	157.3 (61.9)	0.0002
Current smoking (%)	108 (27.0)	45 (32.6)	0.2079
Alcohol pre-cath (%)	157 (46.3)	65 (51.2)	0.3488
Alcohol post-cath (%)	141 (42.3)	56 (47.5)	0.3357
Vessel disease (%)			
1	305 (73.9)	15 (10.3)	
2	80 (19.4)	25 (17.1)	<0.0001
≥3	28 (9.8)	106 (72.6)	
Beta blocker (%)	327 (78.4)	135 (91.8)	0.0003
Ace inhibitor (%)	229 (54.9)	61 (41.8)	0.0063
Plavix (%)	401 (96.2)	57 (38.8)	<0.0001
Statin (%)	415 (99.5)	140 (95.2)	0.0016
Aspirin (%)	410 (98.3)	144 (98.0)	0.7254

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.

Type of Event	BMS/DES (n=417)	CABG (n=147)
Repeat stent (%)	77 (18.5)	N/A
Stent following initial CABG (%)	N/A	23 (15.6)
CABG following initial stent (%)	6 (1.4)	N/A
MI (%)	6 (1.4)	2 (1.4)

• The event rate is not statistically different between those who had a stent vs those who had a CABG, 21.3% vs 17% (p=0.2603).

• 219 (38.8%) 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.

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.

Mean time (in years) to first recurrence (std)	BMS (n=11)	DES (n=79)	BMS/DES (n=89)	CABG (n=25)
6 month 'survivorship'	88.3%	90.6%	90.4%	97.2%
1 year 'survivorship'	83.4%	82.9%	83.0%	85.0%
1.5 year 'survivorship'	83.4%	82.1%	82.2%	83.5%
2 year 'survivorship'	78.0%	81.5%	81.1%	83.5%

Time to First Recurrence Percentile in Years

	BMS (n=11)	DES (n=79)	BMS/DES (n=89)	CABG (n=25)
50th percentile	0.53	0.51	0.51	0.66
75th percentile	1.86	0.72	0.73	0.94
80th percentile	1.86	0.99	1.33	1.03
85th percentile	3.29	1.53	1.67	1.12
90th percentile	3.29	3.23	3.29	1.29
95th percentile	4.24	4.88	4.69	2.44

• Examining the time to the first major adverse cardiac events after treatment, the median time to event was 6 months for stents and 8 months for CABG.

• 75% of the events are captured in the first 8.8 months after the initial procedure for stents and 11.2 months for CABG.

Discussion

- Time to recurrence
 - If we only look at those 8 airmen who had an MI, these events occurred on average 1.6 years after the initial procedure with 50% occurring within 8.2 months.
 - This raises policy questions for the 6 month waiting period after the stent or CABG procedure before the airman returns 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 MIs 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 MIs
 - Many of the airmen had 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 (Abbott et al.),¹ the average age was 64, 29-34% with diabetes and 74-79% with hypertension compared to our study with an average age of 55, 7% with diabetes and 37% with hypertension.

• Also, in the Abbott study 17-19% 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 airman is symptomatic or not. By policy, we may provoke more retreatment 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 6%, increasing to 12% in 2 years and 39% within 5 years. This leaves uncertainty as to why they have dropped out and how this would affect our outcomes of interest.
 - 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 airman chose to no longer renew his medical certificate. In the same manner, if an airman suffers a severe MI, he may not return for a future exam and we will not capture his MI 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 airman 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.

¹Abbott JD, Voss MR, Nakamura M, Cohen HA, Selzer F, Kip KE, Vlachos HA, Wilensky RL, Williams DO. Unrestricted Use of Drug-Eluting Stents Compared With Bare-Metal Stents in Routine Clinical Practice. Journal of the American College of Cardiology 2007; 50(21): 2029-36.