Sudden Deaths Associated with Sickle-Cell Trait in US Military Service Members, January 1995 to June 2011

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Introduction

Sickle cell disease (SCD) is an inherited red blood cell disorder commonly found in people whose ancestors come from sub-Saharan Africa, Spanish-speaking regions in the Western Hemisphere (South America, the Caribbean, and Central America), Saudi Arabia, India, and Mediterranean countries.[1] sickle-cell trait (SCT) occurs in individuals who inherit both a sickle cell gene and a normal gene. Individuals with the trait don't typically have symptoms of the disease.[2] In the United States 8% of the African American population are carriers of SCT.[2] Defense Medical Epidemiology Database (DMED) records indicate that from 2001-2010 there were 8,756 (0.63 per 1,000) first occurrences of service members with an outpatient medical encounter with a diagnosis of SCT (ICD-9 code: 282.5), of which 7,382 (2.92 per 1,000) were black.[3]

Previous studies examined the relationship between SCT and the outcome of sudden death in military recruits and showed an association between SCT: Kark et al. conducted an analysis from 1977-1981 examining the relationship between SCT and the outcome of sudden death in military recruits; the findings of Kark's study showed a higher incidence of age-dependent risk of exercise-related sudden death unexplained by any known pre-existing cause.[4] Previous studies show carriers to have an increased risk of sudden death related to exertional heat illness, exertional rhabdomyolysis and exertional acute renal failure.[5] In 2010 the MSMR reported 358 new episodes of rhabdomyolysis occurring due to physical exertion and/or heat stress.[6] The crude incidence rate was 24.5 per 100,000 person-years (p-yrs) and there was a high number of African-Americans that had an incident occurrence of rhabdomyolysis (rate of 47.1 per 100,000 p-yrs).[6] The editorial comment states: "The higher rate in black, non-Hispanic service members compared to other racial/ethnic subgroup members may reflect, at least in part, increased risk of exertional rhabdomyolysis among individuals with SCT." [6,7,8]

Understanding the trend of SCT, exertional heat illness and sudden death in the military population is of interest. Since the 1980's, the Department of Defense revised health policies by implementing measures to reduce the risk of previously mentioned outcomes (Figure 1). The current analysis will describe demographic characteristics and mortality rates from 1995-2011 in active military service members, with or without SCT, and examine the association of SCT with sudden deaths related to heat injury and exertion related diagnosis.

Methods

Diagnosis from electronic medical records, death records and demographic variables were ascertained for all active component service members in the Armed Forces, during the surveillance period, from the Defense Medical Surveillance System (DMSS). All active component service members with SCT and related diagnosis were identified using ICD-9 codes (282.5, 282.60, 282.69, 282.41, 282.42). Medical encounters with at least one of the ICD-9 codes in any position were considered cases of exertion related conditions: heat stroke/other heat injury (992.0-992.9), acute renal failure (584,584.5-584.9), injury to kidney (866.00-866.03) and exertional rhabdomyolysis (728.88 or 791.3); plus at least one of the following in any position: Volume depletion (276.5), effects of heat (992.0-992.9), effects of thirst (994.3-994.5). The surveillance case definition for sudden death included a death record with a corresponding medical encounter ICD-9 codes (798, 798.1, 798.2). Casualty records were matched to medical records to identify sudden death diagnoses. Mortality rates were calculated using person-time as the denominator.

Fig. 1. Timeline of Key Policies Relating to Sickle-Cell Trait (SCT) and Military Service

DoD issues guidance for all services, removing restrictions on individuals with sickle cell, still screening for SCT; US Air Force has guidelines allowing individuals with SCT and a hemoglobin S content of 40 % or less for air crew and flying occupations.[11]

Army unfitness for flying requirements include SCT; for free fall parachute training restrictions include if SCT and hemoglobin is less than 12.0 g/dl or a history of vaso-occlusive crises. [13]

1981 — **1996** — **2005** — **2007** — **2009**

DoD issues policy that SCT screening is not mandated for military accession ; implementation of preventive measures for heat /exertion related illness or sudden death reduce risks for those with SCT; Hemoglobin S screening after entry for high risk occupations. [12]

Marine guidelines for diving duty standards include a disqualifier if an individual has SCT or symptomology of sickling. [14]

US Air Force medical standards for continued military service disqualifies those with SCT and related disorders. [15]

Table 1. Type of Deaths, Active Component, U.S. Armed Forces, January 1995 - July 2011

	All Deaths		All Deaths (Sickle-Cell trait)		All Deaths (No Sickle-Cell trait)			All Sudden Deaths (Sickle-Cell trait)		All Sudden Deaths (No Sickle-Cell trait)	
	No.	Rate per 100,000	No.	Rate per 100,000	No.	Rate per 100,000	RR	No.	Rate	No.	Rate
Total	17,592	79.0	58	0.3	17,534	78.0	0.0038	0	0.0	248	1.1
Service											
Army	8,340	105.0	15	0.2	8,325	104.0	0.0019	0	0.0	123	1.5
Navy	3,397	58.0	28	0.5	3,369	57.0	0.0088	0	0.0	26	0.4
Air Force	2,655	47.0	11	0.2	2,644	46.0	0.0043	0	0.0	55	1.0
Marine Corps	3,200	112.0	4	0.1	3,196	111.0	0.0009	0	0.0	44	1.5
Sex											
Male	16,512	86.0	48	0.2	16,464	86.0	0.0023	0	0.0	230	1.2
Female	1,080	34.0	10	0.3	1,070	34.0	0.0088	0	0.0	18	0.6
Race/ethnicity											
Non-black, non-Hispanic	14,701	80.0	6	0.0	14,695	80.0	0.0000	0	0.0	203	1.1
Black, non-Hispanic	2,891	70.0	52	1.3	2,839	69.0	0.0188	0	0.0	45	1.1
Age											
<20	1,404	82.0	7	0.4	1,397	82.0	0.0049	0	0.0	17	1.0
20-24	7,117	97.0	21	0.3	7,096	97.0	0.0031	0	0.0	102	1.4
25-29	3,562	74.0	10	0.2	3,552	74.0	0.0027	0	0.0	50	1.0
30-34	2,044	60.0	6	0.2	2,038	59.0	0.0034	0	0.0	26	0.8
35-39	1,745	59.0	6	0.2	1,739	59.0	0.0034	0	0.0	24	0.8
40+	1,720	77.0	8	0.4	1,712	77.0	0.0052	0	0.0	29	1.3
Military occupation											
Combat	6,231	136.0	11	0.2	6,220	136.0	0.0015	0	0.0	57	1.2
Health Care	945	50.0	3	0.2	942	50.0	0.0040	0	0.0	17	0.9
Other	10,416	65.0	44	0.3	10,372	65.0	0.0046	0	0.0	174	1.1

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Results

From January 1995 to July 2011, there were a total of 17,120 service members identified as having SCT (data not shown). The majority of these service members were in the Air Force (24%). During the surveillance period, there were a total of 58 deaths in individuals with a history of heat injury and exertion related diagnosis and SCT across all services. No sudden deaths were ascertained in military service members with SCT. Of the 58 deaths, 8 were exercise related and 7 were training related. In Table 1, the mortality rates for blacks with SCT are 1.3 per 100,000. Overall, there were no previously defined sudden deaths that occurred in service members with SCT during the surveillance period.

Discussion

The results overall show decreased risk of sudden death in military service members that have SCT and heat injury or exertion related diagnosis. In contrast, previous research demonstrated an increased risk in association between SCT and sudden death.

The limitations of this brief analysis include that the use of diagnosis codes for sudden death may vary in the physician's clinical usage and may introduce misclassification bias. In addition, the mass screening for sickle cell may preclude individuals from joining the military or participating in high risk occupations while serving in the military.

Conclusion

As a result of recruitment and health policy reform, the Armed Forces have implemented measures of prevention. Some of these measures include: sickle cell screening (Fig.1), hydration measures and revised training regimens that build endurance levels in trainees. These measures appear to improve health outcomes for service members at risk and can be considered a model for the implementation of certain health policies related to similar demographic and athletic populations.

In October 2011 an Airman with SCT died during training as a result of cardiac arrest, sickling and other diseases of the lung. [16] This record is not included in this analysis since it is beyond the death record surveillance period. In 2011 a summit was held at the Uniformed Services University in Bethesda to address current issues relating to this topic. Further study is recommended to better understand the etiology of sudden death and SCT. [17]

References

1. Facts about Sickle Cell Disease (SCD). Retrieved from http://www.cdc.gov/ncbddd/sicklecell/facts.html
2. Sickle Cell Trait. Retrieved from http://www.cdc.gov/ncbddd/sicklecell/traits.html
3. Armed Forces Health Surveillance Center http://www.afhsc.mil/aboutDmed?clear
4. Kark JA, Posey DM, Schumacher HR, Ruehle CJ. Sickle-cell trait as a risk factor for sudden death in physical training. N Engl J Med. 1987 Sep 24;317(13):781-7.
5. Kark JA, Ward, FT. Exercise and Hemoglobin S. Seminars in hematology. 1994. Jul;31(3):181-225. W.B.Saunders.
6. Update: Exertional Rhabdomyolysis, Active Component, U.S. Armed Forces, 2010. MSMR Medical Surveillance Monthly Report. March 2011. Volume 18, No.3.
7. Data & Statistics. Retrieved from http://www.cdc.gov/NCBDDD/sicklecell/data.html
8. Makaryus JN, Catanzaro JN, Katona KC. Exertional rhabdomyolysis and renal failure in patients with sickle cell trait: is it time to change our approach? *Hematology.* 2007 Aug;12(4):349-52.
9. Gardner JW, Kark JA. Fatal rhabdomyolysis presenting as mild heat illness in military training. *Mil Med.* 1994 Feb;159(2):160-3.
10. Walsh, John J., Page, Steven M. Rhabdomyolysis and compartment syndrome in military trainees. Chapter 10. Recruit Medicine. Pp 165-174.
11. Department of Defense number 6465.1. Retrieved from http://www.dtic.mil/whs/directives/corres/pdf/646501p.pdf
12. Sickle Cell Policy. Retrieved from http://www.health.mil/libraries/HA_Policies_and_Guidelines/97-018.pdf
13. Army Regulation 40-501. Retrieved from http://www.apd.army.mil/pdffiles/r40_501.pdf
14. US Navy Physical Standards Chapter 15. Retrieved from http://www.med.navy.mil/directives/Documents/NAVMED%20P-117%20(MANMED)/Chapter%2015,%20Medical%20Examinations%20(incorporates%20Changes%20128,%20130,%20135-140%20below).pdf
15. US Air Force Medical Examinations Standards. Retrieved from http://www.e-publishing.af.mil/shared/media/epubs/AFI48-123.pdf
16. Airman's Death October 2011. Retrived from: http://www.mysanantonio.com/news/military/article/Rare-condition-killed-Lackland-trainee-3617917.php
17. O'Connor FG, Bergeron MF, Cantrell J et al. ACSM and CHAMP Summit on SCT: Mitigating Risks for Warfighters and Athletes. Med Sci Sports Exerc. 2012 Jul 17.