Prevalence of Wolff-Parkinson-White pattern in a young South East Asian male population

Results of the Singapore Armed Forces Electrocardiogram and Echocardiogram [SAFE] pre-participation screening protocol

Choon Ta NG, Hean Yee ONG, Christopher CHEOK, Terrance CHUA, Chi Keong CHING

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Declaration of conflict of interest: None
**Background**

- Prevalence of **WPW pattern ECG**: 0.1 – 0.2%\(^1\)
- **WPW syndrome**: 0.005-0.07%\(^2,3\)

- ≥ 50% of patients are **asymptomatic**\(^4,5\)

- Preparticipation screening may identify asymptomatic individuals, and allow for **timely intervention**

- Risk of **Sudden Cardiac Death**: 0.03-0.05%/ year. “Front-loaded” in first part of life\(^1,6\)

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2. Au Smith RF. Circulation 1964; 29: 672
5. Goudevenos JA et al. Heart 2000; 83: 29-34
Aim

- This study is a subgroup analysis of the Singapore Armed Forces Electrocardiogram and Echocardiogram (SAFE) pre-participation screening programme.

- It aims to describe the clinical demographics of patients with WPW pattern ECG in a young male Singapore population undergoing pre-participation screening.
The Singapore experience...

results of the Singapore Armed Forces Electrocardiogram and Echocardiogram (SAFE) Pre-participation screening protocol

South East Asia

Size: 694 km²

Population: 5 million

Ethnicity:

- Chinese
- Malays
- Indians
- Others
SAFE Pre-participation Screening Protocol
Singapore Armed Forces Electrocardiogram and Echocardiogram

• Compulsory military service for all able-bodied young Singapore male citizens

• SAFE is a pre-participation ECG-based screening protocol started in 2008 for all conscripts prior to enlistment

• Modeled after the Italian programme\(^1\) for pre-participation screening in athletes; aims to reduce sudden cardiac deaths by identifying conscripts with potentially lethal cardiac conditions

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Methodology

Sample population:
• All able-bodied male Singapore citizens who are about to enlist in the military between the ages of 16.5 and 30 underwent medical screening at a single medical facility from Oct 2008 to May 2009

WPW pattern ECG:
• Defined as presence of delta wave +/- short PR interval on 12-lead resting ECG
Methodology

- Medical History
- Family History
- X-Ray, Audiometry, Visual Acuity, Dental, Labs
- 12-lead Resting ECG *

SAFE Pre-participation Screening Protocol

* All ECG will be interpreted by trained medical officers
SAFE
Clinical Pathway

ECG

Normal

Abnormal

Fulfills ECG checklist *

Yes

No

Group A = Fast Track Echocardiogram

Group B = cardiologist referral

Yes

No

Group C = Further investigations/cardiologist consult

Cardiac findings/symptoms
Family history

Refer to General Cardiologists
(e.g. T inversions, ST depressions)

Refer to Cardiac Electrophysiologists
(e.g. WPW pattern, long QTc, Brugada)
**SAFE Clinical Pathway**

*ECG checklist*

1. **Frontal-plane axis deviation:**
   - Right axis deviation $\geq +120$ degrees or Left axis deviation -30 to -90 degrees

2. **Increased voltage:**
   - Amplitude of R or S wave in a standard lead $\geq 2$mV,
   - S wave in lead V1 or V2 $\geq 3$mV or R wave in lead V5 or V6 $\geq 3$mV

3. **Abnormal Q wave:**
   - $\geq 0.04$seconds in duration or $\geq 25\%$, or QS pattern in two or more leads

4. **Complete Bundle Branch Block with QRS duration $\geq 0.12$seconds:**
   - Right Bundle Branch Block (RBBB)
   - Left Bundle Branch Block (LBBB)

5. **R or R$^1$ wave in lead V1 $\geq 0.5$mV in amplitude and R:S ratio $\geq 1$
### Participants’ demographics

<table>
<thead>
<tr>
<th>Sample size</th>
<th>18,476 subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean: 19.5 [Range 16 to 27]</td>
</tr>
<tr>
<td>Gender</td>
<td>All male subjects</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Chinese 69.3%, South Asians 15.8%, Malays 14.1%, Others 0.9%</td>
</tr>
<tr>
<td>ECG parameters</td>
<td></td>
</tr>
<tr>
<td>Resting HR</td>
<td>76.3bpm [39 to 135bpm]</td>
</tr>
<tr>
<td>PR interval</td>
<td>145.5 ms [76-282ms]</td>
</tr>
<tr>
<td>QRS duration</td>
<td>99.9 ms [70-180ms]</td>
</tr>
<tr>
<td>QTc interval</td>
<td>393.2 ms [300-530ms]</td>
</tr>
</tbody>
</table>
Results
18,476 subjects screened
[Mean age: 19.6; Range 16 – 27]

1285 (7.0%) subjects had abnormal ECG

WPW pattern ECG: 25 subjects (0.14%)
**Results**

WPW pattern ECG: 25 subjects (0.14%)

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>Mean: 18.8 years of age [17-21]</td>
</tr>
<tr>
<td><strong>Blood Pressure</strong></td>
<td>Mean: 116/68mmHg</td>
</tr>
<tr>
<td><strong>Heart Rate</strong></td>
<td>Mean: 76 bpm [60-109]</td>
</tr>
</tbody>
</table>

**Ethnicity**

- Chinese: 19
- Malays: 4
- Indians: 0
- Others: 2

Others vs Indians: 1.4% vs 0.0%

\[ p = 0.02 \]
Results

Symptoms experienced by patients with WPW pattern

- Asymptomatic: n = 21 (84%)
- Chest pain: n = 3 (12%)
- Palpitations: n = 1 (4%)
Results

Type of WPW pattern/Location of Accessory Pathway

Group A:
QRS mainly positive in leads V1 and V2
Location of Accessory Pathway: LA - LV

Group B:
QRS mainly negative in leads V1 and V2
Location of Accessory Pathway: RA - RV

Group A: 15 (60%)
Group B: 10 (40%)

Rosenbaum FF. Am Heart J 1945;29: 281-236
Results

Transthoracic Echocardiogram Findings

All 25 patients with WPW pattern had echocardiogram performed.

2 (8.0%) conscript had Mitral Valve Prolapse.
Results

18, 476 subjects screened
[Mean age: 19.6; Range 16 – 27]

1285 (7.0%) subjects had abnormal ECG

WPW pattern ECG:
25 subjects (0.14%)

WPW Syndrome:
15 subjects (0.08%)

SAFE Pre-participation Screening Protocol
Results – WPW Syndrome

- **15 (60%)** out of 25 patients were subsequently diagnosed by cardiac electrophysiologists to have **WPW syndrome**. Prevalence: 0.08%

- Most patients with WPW syndrome are **asymptomatic**

- **Asymptomatic**
  - n = 12 (80%)

- **Chest pain**
  - n = 2 (13.3%)

- **Palpitations**
  - n = 1 (6.7%)
### Discussion

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size (n)</th>
<th>Age (years)</th>
<th>No of WPW Pattern</th>
<th>Prevalence</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular Screening with ECG and echo in collegiate athletes</td>
<td>964</td>
<td>18 – 21</td>
<td>7</td>
<td><strong>0.7%</strong></td>
<td>Magalski et al. Am J of Med 2011; 124: 511-8</td>
</tr>
<tr>
<td>Prevalence of abnormal ECG in a large unselected population undergoing PPS</td>
<td>32,652</td>
<td>17 [8-78]</td>
<td>42</td>
<td><strong>0.1%</strong></td>
<td>Antonio Pellucia et al. EHJ 2007; 28: 2006-10</td>
</tr>
<tr>
<td>Prevalence of ECG findings in large population-based samples of men and women</td>
<td>47,358</td>
<td>25-74</td>
<td></td>
<td><strong>0.11% (men)</strong> <strong>0.04% (women)</strong></td>
<td>De Bacquer et al. Heart 2000; 84: 625-633</td>
</tr>
</tbody>
</table>

- **Our prevalence of WPW pattern ECG** in a young, male unselected SEA population: **0.14%**
- *May over-estimate the true prevalence* of WPW pattern ECG as results are only generalisable to **males**
Discussion

• Most of the patients with WPW ECG (84%) and WPW syndrome (80%) are asymptomatic.

• Management of asymptomatic WPW pattern remains controversial.

• Risk Stratification is important.

• Invasive EP testing offers the most accurate and direct way to assess the EP properties of the accessory pathway; should be offered in selected asymptomatic patients who accept the risks involved.

• Catheter ablation is curative.
Box 1 Risk factors for cardiac arrest in patients with Wolff–Parkinson–White syndrome

Probable (consensus of several authors)
- Shortest pre-excited RR interval (SPERRI) <250 ms during atrial fibrillation (note that SPERRI cutoffs ranging from 220–270 ms have been proposed)

Possible (not uniformly identified in risk stratification studies)
- Presence of symptoms
- Inducibility of supraventricular tachycardia (SVT)
- Multiple pathways/septal pathways

Box 2 Data relevant to risk–benefit calculations in asymptomatic Wolff–Parkinson–White (WPW) syndrome

Disease specific
- Likelihood of cardiac arrest, asymptomatic WPW: 0.05–0.5%/year

Therapy specific
- Likelihood of long term ablation success: 85%/case
- Likelihood of death from procedure: 0.05%/case
- Modulators of catheterisation risk:
  - age and size
  - heart disease
  - anatomical location of ablation site

Management of asymptomatic Wolff–Parkinson–White syndrome

John K Triedman

Heart 2009;95:1628–1634
Discussion

Study Limitations:

Difficult to ascertain **exact prevalence of WPW** due to possibility of **intermittent or concealed WPW pattern**

Lack of a **standardised protocol** for WPW evaluation
Conclusions

• The prevalence of **WPW pattern ECG** in a young South East Asian male population is 0.14%

• Most of the subjects with WPW pattern ECG are **asymptomatic** (84%), and were incidentally discovered during pre-participation screening.

• **Electrophysiology (EP) study** may be offered for **risk stratification of asymptomatic military conscripts** with WPW pattern

• The **routine inclusion of 12-lead ECG** in pre-participation screening allows for **identification of asymptomatic subjects** with potential lethal cardiac conditions
STANDBY SLIDES
WPW Pattern ECG

- Characterized by delta wave, short PR interval and wide QRS complex on ECG

WPW Syndrome

- Functional bundle branch block with an abnormally short PR interval and paroxysms of Tachycardia or Atrial Fibrillation

John K Triedman. Heart 2009; 96: 1628-34
Wolff L et al. Am Heart J 1930; 5: 685-704
James Kulig et al. Circulation 2010; 122: e480-3
WPW syndrome

Eccentric activation of the ventricular myocardium via an accessory pathway

K = bundle of Kent
J = bundle of James
M = Mahaim fibres

James Kulig et al. Circulation 2010; 122: e480-3
WPW Type B
Recommendations for interpretation of 12-lead electrocardiogram in the athlete

Domenico Corrado\textsuperscript{1*}, Antonio Pelliccia\textsuperscript{2}, Hein Heidbuchel\textsuperscript{3}, Sanjay Sharma\textsuperscript{4},

<table>
<thead>
<tr>
<th>Group 1: common and training-related ECG changes</th>
<th>Group 2: uncommon and training-unrelated ECG changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus bradycardia</td>
<td>T-wave inversion</td>
</tr>
<tr>
<td>First-degree AV block</td>
<td>ST-segment depression</td>
</tr>
<tr>
<td>Incomplete RBBB</td>
<td>Pathological Q-waves</td>
</tr>
<tr>
<td>Early repolarization</td>
<td>Left atrial enlargement</td>
</tr>
<tr>
<td>Isolated QRS voltage criteria for left ventricular hypertrophy</td>
<td>Left-axis deviation/left anterior hemiblock</td>
</tr>
<tr>
<td></td>
<td>Right-axis deviation/left posterior hemiblock</td>
</tr>
<tr>
<td></td>
<td>Right ventricular hypertrophy</td>
</tr>
<tr>
<td></td>
<td>Ventricular pre-excitation</td>
</tr>
<tr>
<td></td>
<td>Complete LBBB or RBBB</td>
</tr>
<tr>
<td></td>
<td>Long- or short-QT interval</td>
</tr>
<tr>
<td></td>
<td>Brugada-like early repolarization</td>
</tr>
</tbody>
</table>
Prevalence of abnormal electrocardiograms in a large, unselected population undergoing pre-participation cardiovascular screening

Antonio Pelliccia¹*, Franco Culasso², Fernando M. Di Paolo¹, Domenico Accettura³, Rocco Cantoni, Fabio Di Lorenzo, Claudio D'Angelo, Roberto Costini⁷, Biagio Cuffari⁸, Enrico Drago⁹, Ricardo Fagard, Giorgio Ferrari⁴, Giancarlo Iacovelli¹², Luigi Landolfi¹³, Angelo, Mario Magnani, Gian Luigi Magagna, Attilio Parisi¹⁶, Angelo R. Pizzi¹⁷, Michele Rosa², Stefano Scipione, Fabio Scognamiglio, Maurizio Casaschi²², and Luigi Di Luigi²³

n = 32 652
Median age: 17 [8-78]
Athletes

Prevalence of WPW pattern ECG: 0.1%

<table>
<thead>
<tr>
<th>ECG abnormalities</th>
<th>Athletes, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative T-waves in precordial/standard leads</td>
<td>751 (2.3)</td>
</tr>
<tr>
<td>RBBB</td>
<td>351 (1.0)</td>
</tr>
<tr>
<td>Increased R/S wave voltages (suggestive of LVH)</td>
<td>247 (0.8)</td>
</tr>
<tr>
<td>Left anterior fascicular block</td>
<td>162 (0.5)</td>
</tr>
<tr>
<td><strong>Pre-excitation pattern</strong></td>
<td><strong>42 (0.1)</strong></td>
</tr>
<tr>
<td>LBBB</td>
<td>19 (0.1)</td>
</tr>
<tr>
<td>Prolonged corrected QT interval</td>
<td>1 (0.003)</td>
</tr>
<tr>
<td>Others (incomplete RBBB, prolonged PR interval, early repolarization pattern)</td>
<td>2280 (7.0)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3853 (11.8)</strong></td>
</tr>
</tbody>
</table>

RBBB, right bundle branch block; LVH, left ventricular hypertrophy; LBBB, left bundle branch block.
1 out of 289 athletes had ECG criteria of WPW

**Prevalence of WPW pattern ECG: 0.3%** [Age range 21-35]
No association was found between prediction of the accessory pathway and the presence of mitral prolapse.

Some patients demonstrating MVP do so as the result of the altered sequence of ventricular activation, rather than as the result of a structural abnormality.
Unselected population in Belgium
Sample size: 47 358
Age range: 25-74
Prevalence of WPW pattern ECG: 0.11% in men, 0.04% in women
“The incidence of SCD in young competitive athletes has substantially declined in the Veneto region of Italy since the introduction of a nationwide systematic screening”
Tachyarrhythmias in WPW syndrome

- Orthodromic AVRT: 70%
- Atrial Fibrillation: 20%
- Antidromic AVRT: 10%

No statistically significant difference in prevalence of WPW between **White** and **Black** race
Discussion

• Most of the patients with WPW ECG (84%) and WPW syndrome (80%) are asymptomatic

30% had documented disappearance of delta wave

Risks of life-threatening arrhythmias decreases with increasing age
<table>
<thead>
<tr>
<th>ECG abnormalities</th>
<th>No of subjects, n (%)</th>
<th>TTE findings (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased R/S wave voltages</td>
<td>782 (4.23%)</td>
<td>Atrial septal aneurysm (4), atrial septal defect (1), Bicuspid aortic valve(6), Mitral valve prolapse(39), Dilated coronary Sinus(1), Dilated left ventricle(1)</td>
</tr>
<tr>
<td>T wave inversions</td>
<td>55 (0.30%)</td>
<td>Atrial septal aneurysm(1), Mitral valve prolapse(3)</td>
</tr>
<tr>
<td>ST Segment Depression</td>
<td>14 (0.08%)</td>
<td>No Structural Abnormality</td>
</tr>
<tr>
<td>AV Conduction Defect: Second Degree Mobitz Type I AV Block, WPW pattern</td>
<td>30 (0.16%)</td>
<td>Mitral valve prolapse(2)</td>
</tr>
<tr>
<td>Ventricular Conduction Defect: RBBB, LBBB, LAFB, LPFB</td>
<td>105 (0.57%)</td>
<td>Mitral valve prolapse(5), Atrial septal aneurysm(1), Atrial septal defect(1), Mitral valve prolapse(13)</td>
</tr>
<tr>
<td>QRS Axis Deviation</td>
<td>163 (0.88%)</td>
<td>Hypertrophic cardiomyopathy(1), Atrial septal aneurysm(1), Atrial septal defect(1), Mitral valve prolapse(13)</td>
</tr>
<tr>
<td>Q wave: ≥ 0.04seconds in duration or ≥ 25%, or QS pattern in two or more leads</td>
<td>20 (0.11%)</td>
<td>No Structural Abnormality</td>
</tr>
<tr>
<td>Arrhythmias: Sinus Bradycardia, Sinus Tachycardia, Intermittent SVT, Frequent Atrial/ Junctional/ Ventricular Ectopics, AF</td>
<td>51 (0.28%)</td>
<td>Mitral valve prolapse(1)</td>
</tr>
<tr>
<td>Others: R in V1 &gt; 0.5mV, R:S&gt; 1, P wave abnormalities, Brugada pattern ECG, Prolonged QT interval</td>
<td>141 (0.75%)</td>
<td>Bicuspid aortic valve(2), Mitral valve prolapse(7)</td>
</tr>
</tbody>
</table>