

UK Armed Forces psychiatric morbidity:

Presenting complaints at MOD Departments of Community Mental Health

July – September 2007

22 July 2008

Issued By:

Craig Corbet
Melanie Tanner
Nick Blatchley
*Defence Analytical
Services and Advice
(DASA)*

For correspondence:

DASA Health Information,
Spur 7, B Block, Ensleigh,
Bath, BA1 5AB.
infoatdasa@dasa.mod.uk

Internet:

[http://www.dasa.mod.uk/
applications/newWeb/www/
index.php?page=66&pu
bType=0](http://www.dasa.mod.uk/applications/newWeb/www/index.php?page=66&pubType=0)

Introduction

1. This is the third publication in a new series of statistical information on psychiatric morbidity among the UK Armed Forces. The report covers the period July - September 2007, for all new referrals of Service personnel to the MOD's Departments of Community Mental Health (DCMHs) for outpatient care, and new admissions to the MOD's in-patient care contractor.

2. DCMHs are specialised psychiatric services based on community mental health teams closely located with primary care services at sites in the UK and abroad. **Information on patients only seen in the primary care system is not currently available.**

3. A rigid pseudo-anonymisation process, and other measures preserving patient confidentiality, has enabled full verification and validation of the DCMH returns, importantly allowing identification of repeat attendances. It also ensured linkage with deployment databases was possible, so that potential effects of deployment could be measured.

4. The first two reports^a in this series provide important background information on data governance. This is summarised later in the section on 'Data, definitions and methods'.

Key points

Initial Assessments at MOD DCMHs

5. During the 3-month period, July – September 2007, 895 new cases of mental disorder were identified within UK Armed Forces personnel, representing a rate of 4.6 per 1,000 strength. Although this is 10% lower than new cases of mental disorder assessed during April – June 2007, not too much should be read into this finding as it could be due to a combination of factors, including possible seasonal variations.

6. Among the 895 personnel with a mental disorder, there were some statistically significant findings, which were broadly consistent with those in the first two reports:

- Royal Marines had statistically significantly lower rates than Army and RAF personnel;
- Females had statistically significantly higher rates than males;
- Other ranks had statistically significantly higher rates than officers.

7. In line with the first two reports, there were no statistically significant differences in the rates of overall mental disorder between those who had deployed and those who had not deployed. This was equally true when looking at the major groupings of mental disorder, with one noticeable exception. There was a statistically significantly higher rate of Post-traumatic stress disorder (PTSD) among those who had deployed compared with those who had not deployed. However, PTSD has remained a rare condition, affecting 40 personnel seen during this 3-month period, who had deployed and 4 who had not deployed.

Admissions to the MOD's In-patient Contractor

8. During the 3-month period July – September 2007, 58 patients were

^a UK Armed Forces psychiatric morbidity: Assessment of presenting complaints at MOD DCMHs and association with deployment on recent operations in the Iraq or Afghanistan theatres of operation January – March 2007 / April – June 2007.

admitted for the first time to the MOD's in-patient care contractor, of which 42 had previously been seen at a DCMH, during 2007. The other 16 patients may have been seen at a DCMH before January 2007.

Results

Initial Assessments at MOD DCMHs

9. During the 3-month period July – September 2007, a total of 1,326 UK Service personnel were recorded as having been seen for assessment as new patients at the MOD's DCMHs and overseas satellites, representing a rate for the period of 6.7 per 1,000 strength^b.

10. **Table 1** provides details of the key socio-demographic and military characteristics of the 1,326 new attendances at the MOD's DCMH during July – September 2007. This includes 85 patients who were seen, but for which no information on presenting complaint was provided – in the previous two reports, cases where no presenting complaint was included in a footnote, rather than in the table.

11. Of the 1,326 new attendances, 895 (67%) were assessed with a mental disorder, representing an overall rate for new cases of mental disorder of 4.6 per 1,000 strength. No mental disorder was recorded at the initial assessment for the remaining 346 patients.

Table 1 - New attendances at the MOD's DCMHs: demographic and military characteristics, numbers and rates (per 1,000 strength), July – September 2007

Characteristic	Strength ¹	All patients seen ²	Patients assessed with a mental disorder			Patients assessed without a mental disorder	Presenting complaint information not provided
			Number	Rate	95% CI		
All	194,600	1,326	895	4.6	(4.3 - 4.9)	346	85
Service							
Royal Navy	31,700	187	112	3.5	(2.9 - 4.2)	71	4
Royal Marines	7,700	28	18	2.3	(1.4 - 3.7)	9	1
Army	110,400	772	546	4.9	(4.5 - 5.4)	174	52
RAF	44,800	325	207	4.6	(4.0 - 5.2)	90	28
Gender							
Males	176,600	1,080	715	4.0	(3.8 - 4.3)	296	69
Females	18,000	232	168	9.3	(7.9 - 10.8)	48	16
Rank							
Officers	33,000	78	50	1.5	(1.1 - 1.9)	20	8
Other ranks	161,600	1,234	833	5.2	(4.8 - 5.5)	324	77
Deployment - Theatres of operation							
Iraq or Afghanistan ^{3,4}	103,100	622	462	4.5	(4.1 - 4.9)	123	37
Of which, Iraq	90,500	557	420	4.6	(4.2 - 5.1)	106	31
Of which, Afghanistan ⁴	29,600	142	102	3.4	(2.8 - 4.1)	26	14
Neither Iraq nor Afghanistan ⁴	91,500	690	421	4.6	(4.2 - 5.0)	221	48
Characteristics not known⁵		14	12			2	0

1. Strengths data rounded to the nearest 100, so subtotal may not sum to the total.

2. Includes 346 patients assessed without a mental disorder and 85 patients for which no information on presenting complaint was provided.

3. Includes personnel who were deployed to either the Iraq, the Afghanistan or both theatres of operation.

4. Does not include personnel deployed to Afghanistan during the period January 2003 to October 2005 (see paragraph 29).

5. Records supplied without identifiers (see paragraph 28).

12. There were some statistically significant differences in the initial assessment rates between various sub-groups of the patients seen during July – September 2007:

- The Army and RAF had similar rates of mental disorder assessment at 4.9 and 4.6 per 1,000 strength respectively, whereas the Royal Marines and Royal Navy had lower rates of 2.3 and 3.5 per 1,000 strength respectively. The rate for the Royal Marines was statistically significantly lower than for the Army and the RAF, and the rate for the Royal Navy was significantly lower than for the Army.

^b Based on a combined strength of approximately 191,400 Regulars and 3,200 Mobilised Reservists in Service on 1 August 2007.

- Female personnel had a statistically significantly higher rate of mental disorder assessment at 9.3 per 1,000 strength (95%CI: 7.9-10.8, N=168) than male personnel, at 4.0 per 1,000 strength (95%CI: 3.8-4.3, N=715);
- The rate for the other ranks was statistically significantly higher than for officers: 5.2 per 1,000 strength (95%CI: 4.8-5.5, N=833) compared to 1.5 per 1,000 strength (95%CI: 1.1-1.9, N=50);
- No statistically significant difference in the overall rates for those identified as deployed to the Iraq or Afghanistan theatres of operation compared to those who were not identified as deployed there.

13. **Table 2** compares numbers of new attendances at the DCMHs who were assessed with a mental disorder during the first, second and third quarters of 2007.

Characteristic	January - March 2007			April - June 2007			July - September 2007		
	Patients assessed with a mental disorder								
	Number ¹	Rate	95% CI	Number ²	Rate	95% CI	Number ³	Rate	95% CI
All	1,158	5.8	(5.4 - 6.1)	996	5.0	(4.7 - 5.4)	895	4.6	(4.3 - 4.9)
Service									
Royal Navy	149	4.6	(3.9 - 5.4)	155	4.9	(4.1 - 5.6)	112	3.5	(2.9 - 4.2)
Royal Marines	22	2.8	(1.8 - 4.3)	22	2.9	(1.8 - 4.4)	18	2.3	(1.4 - 3.7)
Army	676	5.9	(5.5 - 6.4)	543	4.8	(4.4 - 5.2)	546	4.9	(4.5 - 5.4)
RAF	244	5.2	(4.6 - 5.9)	211	4.7	(4.0 - 5.3)	207	4.6	(4.0 - 5.2)
Gender									
Males	890	4.9	(4.6 - 5.2)	748	4.2	(3.9 - 4.5)	715	4.0	(3.8 - 4.3)
Females	201	11.0	(9.5 - 12.5)	183	10.1	(8.7 - 11.6)	168	9.3	(7.9 - 10.8)
Rank									
Officers	82	2.5	(1.9 - 3.0)	61	1.8	(1.4 - 2.3)	50	1.5	(1.1 - 1.9)
Other ranks	1,009	6.0	(5.7 - 6.4)	870	5.3	(4.9 - 5.6)	833	5.2	(4.8 - 5.5)
Deployment - Theatres of operation									
Iraq or Afghanistan ^{4,5}	518	5.1	(4.7 - 5.6)	432	4.4	(4.0 - 4.8)	462	4.5	(4.1 - 4.9)
Of which, Iraq	480	5.3	(4.8 - 5.8)	390	4.4	(4.0 - 4.8)	420	4.6	(4.2 - 5.1)
Of which, Afghanistan ⁵	93	3.9	(3.1 - 4.8)	83	3.5	(2.8 - 4.3)	102	3.4	(2.8 - 4.1)
Neither Iraq nor Afghanistan ⁵	573	5.7	(5.3 - 6.2)	499	5.0	(4.6 - 5.5)	421	4.6	(4.2 - 5.0)
Characteristics not known⁶	67			65			12		

1. As 156 records have been excluded for lack of assessment details, these data represent a minimum.
2. As 81 records have been excluded for lack of assessment details, these data represent a minimum.
3. As 85 records have been excluded for lack of assessment details, these data represent a minimum.
4. Includes personnel who were deployed to either the Iraq, the Afghanistan or both theatres of operation.
5. Does not include personnel deployed to Afghanistan during the period January 2003 to October 2005.
6. Records supplied without identifiers (see paragraph 28).

14. Overall, there was an apparent 10% decline in the number of patients assessed with a mental disorder during July – September, compared to April – June 2007 (895 compared to 996). The breakdown of rates for each sub-grouping shown appears to be largely consistent between the two periods, except amongst Royal Navy personnel. The overall decline is probably accounted for by a combination of factors including:

- A 1.4% fall in the number of regular personnel in the UK Armed Forces (approximately 3,000 less in August 2007 than in May 2007);
- The data for April to June 2007 may contain an overcount of personnel also seen in 2006. As DASA receive more data from DCMHs, patients who have been seen previously within the same episode of care can be excluded from analysis.
- Roulements to Iraq and Afghanistan have mostly occurred during March/April and September/October. It is not known if this has had a greater impact on the data for the third quarter than for previous quarters;
- Seasonal variations.

15. **Table 3** provides details of the types of presenting complaints, by ICD-10 grouping, for the 1,241 patients seen for the first time during July – September 2007, where information was provided, and compares with the data for the previous two quarters. Rates for specific assessment groupings were similar for the patients seen in July – September 2007 as they were for those seen during April - June 2007.

16. The rates for some specific assessment groupings (namely mood disorders and neurotic disorders, in particular Adjustment disorders) were statistically significantly lower during July – September compared to January – March. However, interpretation of these findings requires caution, since the data for January – March may contain an overcount^c of personnel also seen in 2006.

ICD-10 description	January - March 2007			April - June 2007			July - September 2007		
	All patients seen ¹	Rate	95% CI	All patients seen ²	Rate	95% CI	All patients seen ³	Rate	95% CI
All patients seen	1,651			1,380			1,326		
All patients assessed with a mental disorder	1,158	5.8	(5.4 - 6.1)	996	5.0	(4.7 - 5.3)	895	4.6	(4.3 - 4.9)
Psychoactive substance use	101	0.5	(0.4 - 0.6)	121	0.6	(0.5 - 0.7)	124	0.6	(0.5 - 0.7)
<i>of which disorders due to alcohol⁴</i>	--	--	--	115	0.6	(0.5 - 0.7)	121	0.6	(0.5 - 0.7)
Mood disorders	264	1.3	(1.2 - 1.5)	241	1.2	(1.1 - 1.4)	191	1.0	(0.8 - 1.1)
<i>of which Depressive episode</i>	208	1.0	(0.9 - 1.2)	207	1.0	(0.9 - 1.2)	162	0.8	(0.7 - 1.0)
Neurotic disorders	712	3.5	(3.3 - 3.8)	580	2.9	(2.7 - 3.2)	525	2.7	(2.5 - 2.9)
<i>of which PTSD</i>	55	0.3	(0.2 - 0.3)	38	0.2	(0.1 - 0.2)	44	0.2	(0.2 - 0.3)
<i>of which Adjustment disorders</i>	399	2.0	(1.8 - 2.2)	365	1.8	(1.7 - 2.0)	306	1.6	(1.4 - 1.7)
Other mental disorders	81	0.4	(0.3 - 0.5)	54	0.3	(0.2 - 0.3)	55	0.3	(0.2 - 0.4)
No mental disorder	337			303			346		
No assessment details	156			81			85		

1. Includes 156 records where data on presenting complaint was not provided.
2. Includes 81 records where data on presenting complaint was not provided.
3. Includes 85 records where data on presenting complaint was not provided.
4. Specific data not available for disorders due to use of alcohol during January - March 2007.

^c See second report in this series covering April – June DCMH assessments (paragraph 31 – 32).

17. **Table 4** provides details of the types of mental disorder by the patients' past deployment on recent operations in the Iraq or Afghanistan theatres. The rate ratios presented provide a comparison of cases seen between personnel identified as having deployed to a theatre and those who have not been identified as having deployed to either theatre.

ICD-10 description	All patients seen	Deployment - Theatres of operation								Neither	Not known ³		
		Iraq or Afghanistan ^{1,2}				of which							
		Patients seen ⁴	Rate ratio ⁵	95% CI		Patients seen ⁴	Rate ratio ⁵	95% CI				Patients seen	Patients seen
All patients seen⁶	1,326	622			557				142		690	14	
All patients assessed with a mental disorder	895	462	1.0	(0.9 - 1.1)	420	1.0	(0.9 - 1.2)		102	0.7	(0.6 - 0.9)	421	12
Psychoactive substance use disorders due to alcohol	124	65	1.0	(0.7 - 1.4)	61	1.0	(0.7 - 1.5)		13	0.7	(0.4 - 1.2)	59	0
Mood disorders	121	63	1.0	(0.7 - 1.4)	59	1.0	(0.7 - 1.5)		13	0.7	(0.4 - 1.3)	58	0
Depressive episode	191	89	0.8	(0.6 - 1.1)	82	0.8	(0.6 - 1.1)		11	0.3	(0.2 - 0.6)	100	2
Neurotic disorders	162	68	0.7	(0.5 - 0.9)	62	0.7	(0.5 - 0.9)		10	0.3	(0.2 - 0.6)	92	2
PTSD	525	290	1.1	(0.9 - 1.3)	259	1.1	(1.0 - 1.4)		78	1.1	(0.8 - 1.4)	228	7
Adjustment disorders	44	40	8.9	(3.2 - 24.8)	33	8.3	(3.0 - 23.5)		18	13.9	(4.7 - 41.2)	4	0
Other mental and behavioural disorders	306	177	1.3	(1.0 - 1.6)	160	1.3	(1.0 - 1.6)		40	1.0	(0.7 - 1.4)	124	5
No mental disorder	55	18	0.5	(0.3 - 0.8)	18	0.5	(0.3 - 0.9)		0			34	3
No assessment details	346	123			106				26			221	2
	85	37			31				14			48	0

1. Includes personnel who were deployed to either the Iraq, the Afghanistan or both theatres of operation.
2. Does not include personnel deployed to Afghanistan during the period January 2003 to October 2005 (see paragraph 29).
3. Records supplied without identifiers (see paragraph 28).
4. Some patients had deployed to both Iraq and Afghanistan; 60 of those assessed with a mental disorder who had deployed to at least one of these theatres.
5. Rate ratio compares personnel identified as deployed to these theatres of operation with those not identified as deployed to either theatre of operation.
6. Includes 346 patients assessed without a mental disorder and 85 patients for which no information on presenting complaint was provided.

18. Of the 895 patients initially assessed as having a mental disorder, 462 were identified as having deployed in either the Iraq or Afghanistan theatres of operation, of which 420 to Iraq, 102 to Afghanistan, and 60 to both. 421 patients were not identified as having deployed to these operational theatres.

19. There were no statistically significant differences in the rates of overall mental disorder, or of the major mental disorder groupings, between those deployed to recent operations in the Iraq or Afghanistan theatres and those not identified as having deployed there, with one noticeable exception.

20. There was a statistically significantly higher rate of PTSD among those deployed to the Iraq or Afghanistan theatres of operation compared with those not deployed there: the rate ratio was 8.9 (95%CI 3.2–24.8). However, although personnel who had deployed to the Iraq or Afghanistan theatres of operation were nearly nine times more likely to present symptoms of PTSD compared to those who had not, PTSD has remained a rare condition. The numbers involved were low, with 40 cases seen amongst those identified as having deployed, and 4 among those not identified as having deployed.

21. Personnel who had deployed to the Afghanistan theatre of operation were nearly 14 times more likely to present symptoms of PTSD compared to those who had not deployed to either the Iraq or Afghanistan theatres of operation (IRR: 13.9, 95%CI: 4.7–41.2). This is not statistically significantly greater than for the comparison of personnel who had deployed to either the Iraq or Afghanistan theatre of operation and those who had not deployed to either (IRR: 8.9, 95%CI: 3.2–24.8).

22. These overall findings are consistent with those in the previous two reports for January – March 2007 and April – June 2007. The additional risk of presenting with PTSD, highlighted in this report, is higher than for the previous two quarters: 8.9 per 1,000 strength compared to 3.4 and 3.7 per 1,000 strength in January – March and April – June 2007 respectively. However, this difference between quarters is not statistically significant.

Admissions to the MOD's In-patient Contractor

23. During the 3-month period July - September 2007, there were 74 admissions of Service personnel to the MOD's in-patient contractor. Of these, 58 personnel were admitted for the first time, representing an admission rate of 0.3 per 1,000 strength (**Table 5**). This corresponds to about 5% of the referrals to the DCMHs.

24. There was no statistically significant difference in the admission rates of those deployed to the Iraq or Afghanistan theatres of operation and those who had not been deployed. **Table 5** includes revised figures for admissions to the in-patient contractor during January – March and April – June 2007, following confirmation that 5 of the patients recorded in the last report, had been admitted there previously.

25. Of the 58 personnel admitted for the first time during July – September 2007, 42 had been seen at a DCMH sometime during January – September 2007. There are several possible reasons why the remaining 16 patients were admitted to the in-patient contractor, without DASA's records showing that they had been seen at a DCMH during the 9 month period. The two most likely are:

- They may have been seen at a DCMH before 2007, and hence would not have been captured by the new system;
- In emergency situations, General Practitioners can admit patients directly to the in-patient contractor, whilst informing DCMHs by telephone.

Table 5 - Admissions at the MOD's in-patient contractor: comparison of demographic and military characteristics

Characteristic	January - March 2007			April - June 2007			July - September 2007		
	Patients assessed with a mental disorder								
	Number	Rate	95% confidence interval	Number	Rate	95% confidence interval	Number ¹	Rate	95% confidence interval
All Admissions²	88			85			74		
First admissions	74	0.4	(0.3 - 0.5)	66	0.3	(0.3 - 0.4)	58	0.3	(0.2 - 0.4)
Service									
Naval Service ³	15	0.4	(0.2 - 0.6)	10	0.3	(0.1 - 0.5)	9	0.2	(0.1 - 0.4)
Army	50	0.4	(0.3 - 0.6)	44	0.4	(0.3 - 0.5)	38	0.3	(0.2 - 0.5)
RAF	9	0.2	(0.1 - 0.4)	12	0.3	(0.1 - 0.5)	10	0.2	(0.1 - 0.4)
Gender									
Males	65	0.4	(0.3 - 0.4)	54	0.3	(0.2 - 0.4)	47	0.3	(0.2 - 0.3)
Females	9	0.5	(0.2 - 0.9)	12	0.7	(0.3 - 1.2)	10	0.6	(0.3 - 1)
Rank									
Officers	4	0.1	(0 - 0.3)	6	0.2	(0.1 - 0.4)	6	0.2	(0.1 - 0.4)
Other ranks	70	0.4	(0.3 - 0.5)	60	0.4	(0.3 - 0.5)	51	0.3	(0.2 - 0.4)
Deployment - Theatres of operation									
Iraq or Afghanistan ^{4,5}	39	0.4	(0.3 - 0.5)	29	0.3	(0.2 - 0.4)	28	0.3	(0.2 - 0.4)
Of which, Iraq	39	0.4	(0.3 - 0.6)	29	0.3	(0.2 - 0.5)	24	0.3	(0.2 - 0.4)
Of which, Afghanistan ⁵	6	0.3	(0.1 - 0.6)	7	0.3	(0.1 - 0.6)	9	0.3	(0.1 - 0.6)
Neither Iraq nor Afghanistan ⁵	35	0.4	(0.2 - 0.5)	37	0.4	(0.3 - 0.5)	29	0.3	(0.2 - 0.5)
Readmissions	14			19			16		

1. One record provided without valid identifiers.
2. Includes patients who have been readmitted.
3. Royal Navy and Royal Marines combined to avoid disclosure.
4. Includes personnel who were deployed to either the Iraq, the Afghanistan or both theatres of operation.
5. Does not include personnel deployed to Afghanistan during the period January 2003 to October 2005 (see paragraph 28).

Points to Note

26. Interpretation of the findings in this report continues to require caution. They do not cover the full picture of all mental disorders in the UK Armed Forces. Personnel may have been seen in Primary care, who did not require, or who did not wish, onward referral to the DCMHs. It is also possible that the support through a strong culture of comradeship within the Armed Forces, may have served to minimise the number and severity of symptoms experienced by some cases. It is important therefore to view the results presented here alongside independent academic research, such as that conducted by the Kings Centre for Military Health Research, who collect subjective information on self-reported mental health, through the use of confidential surveys^d.

Data, definitions and methods

27. DCMH staff record the initial psychiatric assessment during a patient's first appointment, based on presenting complaints. The information is provisional and final diagnoses may differ as some patients do not present the full range of symptoms, signs or clinical history during their first appointment. The psychiatric assessment data were categorised into three standard groupings of common mental disorders used by the World Health Organisation's International Statistical Classification of Diseases and Health-Related Disorders 10th edition (ICD-10).

28. A number of patients present to DCMHs with symptoms that require the treatment skills of DCMH staff, whilst not necessarily having a specific and identifiable mental disorder. In the **Findings** section, these cases are referred to as "assessed without a mental disorder".

29. In total, 1,588 records, covering initial assessments at DCMHs during the 3-month period July - September 2007, were sent to DASA for analysis. Following a range of validation and verification quality assurance procedures, 262 of the 1,588 records submitted were excluded from the main analysis. These applied to duplicates and repeat attendances in the same episode of care, and civilian or non-UK military personnel not covered by this report. 14 cases were included in the analysis, but since they were supplied in fully anonymised format, could not be verified or linked.

30. Deployment data, used to calculate denominators, cover several operational deployments between November 2001 and June 2007, although person level deployment data for Afghanistan between 1 January 2003 and 14 October 2005 were not available. About 4 per cent of the deployment records were not successfully validated against the "gold standard" personnel records held by the Service Personnel and Veterans Agency^e. **To be accurate, this report compares those who have been deployed with those who have not been identified as having deployed.**

References

- 1 Hyams KC, Wignall FS, Roswell R. War syndromes and their evaluation: from the U.S. Civil War to the Persian Gulf War. *Annals of Internal Medicine*; **125**: 398-405.
- 2 Jones E, Hodgins-Vermaas R, McCartney H et al. Post-combat syndromes from the Boer War to the Gulf: a cluster analysis of their nature and attribution. *British Medical Journal* 2002; **324**: 321-324
- 3 Hoge CW, Castro CA, Messer SC et al. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *New England Journal of Medicine* 2004; **351**: 13-22.
- 4 Hotopf M, Fear NT, Browne T et al. The health of UK military personnel who deployed to the 2003 Iraq war: a cohort study. *The Lancet*, **367**: 1731-1741.
- 5 Pearson ES, Hartley HO, 1954. *Biometrika tables for statisticians volume I*. Cambridge: Cambridge University Press.

^d Their findings are published in the peer-reviewed medical literature and are freely available in the public domain at [URL:http://www.kcl.ac.uk/kcmhr/information/publications/publications.html](http://www.kcl.ac.uk/kcmhr/information/publications/publications.html).

^e It is reassuring that the research carried out by the Kings Centre for Military Health Research on a large tri-Service sample of personnel deployed during the first phase of Op TELIC in 2003, who were identified from DASA's deployment database, reported a cohort error rate of less than 0.5 per cent⁴