# Diagnostic sensitivity and false positive AKI alerts through unlinking of an integrated Grampian biochemistry service – Report for the UK Renal Registry

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### Background

Grampian has a relatively unique position of an integrated biochemistry service for the whole region. This is helpful when studying AKI, where accurate baseline is crucial and one missing test result can alter findings. Ealert AKI systems that appear to perform reasonably in Grampian may not perform as well in other areas if care is shared across different services that are not integrated.

Grampian biochemistry service contains two linked laboratories in Aberdeen and Elgin. Of 417295 patients with biochemistry profiles in Grampian 1999-2009, there were 32053 patients (7.7%) that had blood tests processed by each of the two laboratories (i.e. border patients). Without integration of the two laboratories, this minority of patients may be at risk of being misclassified by an automated detection algorithm. Note that in other areas the proportion of patients in border areas will vary greatly, but this analysis here has been restricted only to those 32053 bordering patients (integration will have made no difference in the others).

#### Methods

In this analysis the NHS England AKI detection algorithm was compared for each year from 2003-2008 between two set ups:

- 1. Grampian biochemistry service as it functions in current practice (two linked laboratories providing an integrated service)
- 2. If the Aberdeen and Elgin laboratories were no longer integrated (hypothetical)

AKI identified in the current integrated service was regarded as "reference standard" for this study. The 32053 patients in bordering areas with and without AKI blood tests were compared in 2x2 plots with sensitivity and false positive rates.

Table 1 - Number o	f natients with AK	Te-alerts in integrated	(reference)	and non-integrated services

Total         31,080         973         32,053         false positive         3.5         (2.4-4.8)           2004         Neg.         Pos.         Total           "true" normal         30,854         46         30,900           "true" abnormal         180         973         1,153         sensitivity         84.4         (82.2-86.4)           Total         31,034         1,019         32,053         false positive         4.5         (3.3-6.0)           2005         Neg.         Pos.         Total         Total         88.2         (86.2-89.9)           "true" abnormal         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total         86.0         (84.1-87.7)         1,532         sensitivity         86.0         (84.1-87.7)	Integrated (reference standard)		Not integrate	d				
"true" abnormal Total         147         939         1,086         sensitivity         86.5         (84.3-88.4)           2004         Neg.         Pos.         Total         3.5         (2.4-4.8)           2004         Neg.         Pos.         Total         3.5         (2.4-4.8)           "true" normal "true" abnormal Total         30,854         46         30,900         30,900         4.5         (82.2-86.4)           Total         31,034         1,019         32,053         false positive         4.5         (3.3-6.0)           2005         Neg.         Pos.         Total         4.5         (3.3-6.0)           "true" normal "true" abnormal Total         30,781         47         30,828         50         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.	2003		Neg.	Pos.	Total			
Total         31,080         973         32,053         false positive         3.5         (2.4-4.8)           2004         Neg.         Pos.         Total           "true" normal         30,854         46         30,900           "true" abnormal         180         973         1,153         sensitivity         84.4         (82.2-86.4)           Total         31,034         1,019         32,053         false positive         4.5         (3.3-6.0)           2005         Neg.         Pos.         Total         Total         88.2         (86.2-89.9)           "true" abnormal         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           2006         Neg.         Pos.         Total         4.2         (3.1-5.5)           2006         "true" normal         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal         30,598         55         30,653         sensitivity         84.1         (82.1-86		"true" normal	30,933	34	30,967			
Neg.   Pos.   Total   30,854   46   30,900   4.5   (3.3-6.0)		"true" abnormal	147	939	1,086	sensitivity	86.5	(84.3-88.4)
"true" normal         30,854         46         30,900           "true" abnormal         180         973         1,153         sensitivity         84.4         (82.2-86.4)           Total         31,034         1,019         32,053         false positive         4.5         (3.3-6.0)           2005         Neg.         Pos.         Total         Total         88.2         (86.2-89.9)           "true" abnormal         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total           "true" normal         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive <t< th=""><th></th><th>Total</th><th>31,080</th><th>973</th><th>32,053</th><th>false positive</th><th>3.5</th><th>(2.4-4.8)</th></t<>		Total	31,080	973	32,053	false positive	3.5	(2.4-4.8)
"true" abnormal Total         180         973         1,153         sensitivity false positive         84.4         (82.2-86.4)           2005         Neg.         Pos.         Total         Total         30,781         47         30,828         sensitivity         88.2         (86.2-89.9)           "true" abnormal "true" abnormal Total         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total           "true" normal true" abnormal Total         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal "true" abnormal Total         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total	2004		Neg.	Pos.	Total			
Total         31,034         1,019         32,053         false positive         4.5         (3.3-6.0)           2005         Neg.         Pos.         Total         Total         "true" normal "true" abnormal "true" abnormal "true" abnormal "true" abnormal "true" normal "true" normal "true" abnormal "true" abnor		"true" normal	30,854	46	30,900			
2005         Neg.         Pos.         Total           "true" normal         30,781         47         30,828           "true" abnormal         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total           "true" normal         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal         30,598         55         30,653           "true" abnormal         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673         4.5         (3.4-5.8)		"true" abnormal	180	973	1,153	sensitivity	84.4	(82.2-86.4)
"true" normal         30,781         47         30,828         sensitivity         88.2         (86.2-89.9)           Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006         Neg.         Pos.         Total         Total         Vermitter normal         30,465         56         30,521         Sensitivity         86.0         (84.1-87.7)         86.0         (84.1-87.7)         1,532         Sensitivity         86.0         (84.1-87.7)         1,532         1,532         1,432		Total	31,034	1,019	32,053	false positive	4.5	(3.3-6.0)
"true" abnormal Total         145         1,080         1,225         sensitivity         88.2         (86.2-89.9)           2006         Neg.         Pos.         Total         Total         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           2007         "true" abnormal Total         30,680         1,317         1,532         sensitivity         86.0         (84.1-87.7)           2007         Neg.         Pos.         Total         30,598         55         30,653           "true" normal "true" abnormal Total         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         "true" normal         30,598         55         30,653         false positive         4.5         (3.4-5.8)           2008         "true" normal         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)	2005		Neg.	Pos.	Total			
Total         30,926         1,127         32,053         false positive         4.2         (3.1-5.5)           2006 "true" normal "true" abnormal Total         Neg. 30,465         Pos. 56         Total 30,521         sensitivity         86.0         (84.1-87.7)           1 Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007 "true" normal "true" abnormal Total         Neg. 30,598         55         30,653 30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008 "true" normal         Neg. 30,594         Pos. 79         Total 30,673         Total         Total		"true" normal	30,781	47	30,828			
2006         Neg.         Pos.         Total           "true" normal         30,465         56         30,521           "true" abnormal         215         1,317         1,532         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal         30,598         55         30,653           "true" abnormal         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673		"true" abnormal	145	1,080	1,225	sensitivity	88.2	(86.2-89.9)
"true" normal         30,465         56         30,521         sensitivity         86.0         (84.1-87.7)           Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total           "true" normal "true" abnormal Total         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673		Total	30,926	1,127	32,053	false positive	4.2	(3.1-5.5)
"true" abnormal Total         215         1,317         1,532         sensitivity         86.0         (84.1-87.7)           2007         Neg.         Pos.         Total         Total         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           "true" abnormal "true" abnormal Total         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673	2006		Neg.	Pos.	Total			
Total         30,680         1,373         32,053         false positive         4.1         (3.1-5.3)           2007         Neg.         Pos.         Total         Total           "true" normal "true" abnormal Total         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673		"true" normal	30,465	56	30,521			
2007         Neg.         Pos.         Total           "true" normal         30,598         55         30,653           "true" abnormal         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673		"true" abnormal	215	1,317	1,532	sensitivity	86.0	(84.1-87.7)
"true" normal         30,598         55         30,653         sensitivity         84.1         (82.1-86.0)           "true" abnormal         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673         30,673		Total	30,680	1,373	32,053	false positive	4.1	(3.1-5.3)
"true" abnormal         222         1,178         1,400         sensitivity         84.1         (82.1-86.0)           Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008         Neg.         Pos.         Total           "true" normal         30,594         79         30,673	2007		Neg.		Total			
Total         30,820         1,233         32,053         false positive         4.5         (3.4-5.8)           2008 "true" normal         Neg. 30,594         Pos. 79         Total 30,673		"true" normal	30,598	55	30,653			
2008 Neg. Pos. Total "true" normal 30,594 79 30,673		"true" abnormal	222	1,178	1,400	sensitivity	84.1	(82.1-86.0)
"true" normal 30,594 79 30,673		Total	30,820	1,233	32,053	false positive	4.5	(3.4-5.8)
	2008			Pos.	Total			
"true" abnormal 187 1,193 1,380 sensitivity 86.4 (84.5-88.2)		"true" normal	30,594	79	30,673			
		"true" abnormal	187	1,193	1,380	sensitivity	86.4	(84.5-88.2)
<b>Total</b> 30,781 1,272 32,053 false positive 6.2 (4.9-7.7)		Total	30,781	1,272	32,053	false positive	6.2	(4.9-7.7)

## **Findings**

Approximately 10-15% of detectable AKI would be missed in patients in bordering areas if laboratories were not integrated. In addition  $^{\sim}5\%$  of patients would be alerted as AKI who would not if more complete integrated data were available.

## Limitations

This analysis uses the NHS England algorithm in an integrated service as reference standard, but even in this setting misclassification of patients can occur. These findings also only apply to those patients with blood tests processed in both laboratories. This is a minority of patients in Grampian and will vary in different regions.