

**Gram-positive Bacteria Typing Laboratory, Microbiology Department, Fiona Stanley Hospital, PathWest Laboratory Medicine – WA**  
**and**  
**Australian Collaborating Centre for Enterococcus and Staphylococcus Species (ACCESS) Typing and Research**  
**School of Veterinary and Life Sciences, Murdoch University and School of Biomedical Sciences, Curtin Univeristy**

**Western Australian  
Methicillin-Resistant *Staphylococcus aureus* (MRSA)  
Epidemiology and Typing Report**

**July 1 2013 to June 30 2014**

**Prepared By:**

**A/Prof Geoffrey Coombs**

**School of Veterinary and Life Sciences, Murdoch University  
Senior Clinical Scientist, Department of Microbiology, PathWest Laboratory Medicine – WA, Fiona Stanley Hospital**

**Ms Julie Pearson**

**Medical Scientist-in-Charge, Department of Microbiology, PathWest Laboratory Medicine-WA, Fiona Stanley Hospital**

**A/Prof Owen Robinson**

**School of Veterinary and Life Sciences, Murdoch University  
Consultant, Department of Microbiology and Infectious Diseases, PathWest Laboratory Medicine-WA, Royal Perth Hospital and Fiona Stanley Hospitals**

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## 2. Background

To prevent MRSA from becoming established in Western Australian acute care hospitals a statewide management policy was introduced in 1982. The mainstays of the program include a comprehensive and effective outbreak, identification and management policy. **The incorporation of a central epidemiological typing laboratory that uses techniques to enable the rapid identification of MRSA clones has been pivotal in preventing MRSA from becoming established in Western Australian hospitals (1).**

**As a result of the MRSA policy Western Australian hospitals have maintained a low prevalence of healthcare-associated MRSA (HA-MRSA) (micro-alert C MRSA) compared with the rest of Australia (2).** In the 2011 Australian Group for Antimicrobial Resistance programs MRSA accounted for 30.3% of nosocomial-onset *S. aureus* infections ranging from 19.9% in WA to 36.8% in New South Wales and the Australian Capital Territory (NSW/ACT), of which 18.2% were HA-MRSA ranging from 4.5% in WA to 28.0% in NSW/ACT.

Since 1991, community-associated MRSA (CA-MRSA) clones (micro-alert B MRSA) have been associated with a dramatic ascent in the number of MRSA notifications and infections in WA, and are increasingly recognized as a major cause of nosocomial-onset MRSA infections (3). However the proportion of *S. aureus* nosocomial infections that are caused by CA-MRSA clones is similar to that found in the Western Australian community, **suggesting CA-MRSA clones have not successfully found a niche in the Western Australian healthcare system but are imported from the community into hospitals (4).**

In addition to distinguishing micro-alert C MRSA clones from micro-alert B MRSA clones the typing laboratory at Fiona Stanley Hospital PathWest-WA and ACCESS Typing and Research provides information on the emergence, transmission and evolution of novel MRSA clones in the Western Australian community (5-12). **Since 2010 there has been an exponential increase in PVL-positive CA-MRSA clones in WA; particularly in the Pilbara and Kimberley health regions (7, 13, 14). Of recent concern has been the widespread emergence of the trimethoprim resistant PVL-positive ST5-IV [2B] clone (WA121 MRSA).** Having an understanding on the emergence of such clones may assist in antimicrobial prescribing recommendations and patient health care (15-17) .

### 3. Overview

From July 1 2013 to June 30 2014 9,576 MRSA were referred to the PathWest-WA Gram-positive Typing Laboratory, a 14.5% increase from the 8,358 MRSA referred in 2012/2013.

Isolates were characterised as:

- Micro-alert C MRSA. The clone type was identified
- Micro-alert B Panton Valentine leucocidin (PVL)-negative MRSA
- Micro-alert B PVL-positive MRSA. The clone type was identified

Only unique isolates (duplicate isolates excluded) are presented in this report.

#### MRSA

Of the 7,741 unique MRSA isolates referred between July 2013 and June 2014 7,659 (98.9%) were patient isolates and 82 (1.1%) were from health care workers. 6,378 (82.4%) were from clinical specimens and 1,363 (17.6%) were from screening swabs. The isolates were characterised as:

- Micro-alert C MRSA: 1,165 (15.1%)
- Micro-alert B MRSA: 6,576 (84.9%)

A significant difference in the mean ages of micro-alert C and micro-alert B infected patients and PVL-positive and PVL-negative infected patients was identified ( $P < 0.0001$ ).

- Micro-alert C MRSA: 66.6 years (median 77 years)
  - PVL positive micro-alert C MRSA: 35.7 years (median 30 years)
  - PVL negative micro-alert C MRSA: 74.2 years (median 80 years)
- Micro-alert B MRSA: 39.1 years (median 35 years)
  - PVL positive micro-alert B MRSA: 26.6 years (median 24 years)
  - PVL negative micro-alert B MRSA: 49.8 years (median 51 years)

#### Micro-Alert C MRSA

Since 2003/2004 the number of MRSA characterised as micro-alert C MRSA has increased from 575 to 1,165 isolates in 2013/2014. The increase has primarily been due to ST22-IV [2B] (EMRSA-15), a healthcare-associated MRSA predominately found in Western Australian long term care facility patients and in healthcare workers from the United Kingdom.

Micro-alert C MRSA clones isolated:

Clone	Number	% MRSA	% micro-alert C MRSA
ST22-IV [2B] (EMRSA-15)	954	12.3	81.8
PVL-positive ST22-IV [2B]	51	0.7	4.4
ST8-IV [2B] (USA300)	100	1.3	8.6

Clone	Number	% MRSA	% micro-alert C MRSA
ST772-V [5C2] (Bengal Bay MRSA)	26	0.3	2.2
ST239-III [3A] (Aus-2/3 EMRSA)	20	0.3	1.7
ST5-II [2A] (New York Japan MRSA/USA100)	12	0.1	0.9
Other	2	0.1	0.4
<b>Total</b>	<b>1,165</b>	<b>15.1</b>	<b>100</b>

### Micro-Alert B MRSA

Since 2003/2004 the number of MRSA characterised as micro-alert B MRSA has increased from 2,073 to 6,577 isolates. For the same time period the proportion of PVL-positive micro-alert B MRSA has increased from 2% to 41%. Although the increase in PVL-positive isolates has primarily been due to the expansion of ST93-IV [2B] (Queensland CA-MRSA) several PVL positive micro-alert B clones have been isolated in Western Australia including:

PVL-positive Micro-Alert B Clones	Number	% MRSA	% micro-alert B MRSA
ST93-IV [2B] (Queensland CA-MRSA)	1,768	22.8	26.9
ST5-IV [2B] (WA 121)	506	6.5	7.7
ST30-IV [2B] (West Samoan Phage Pattern)	286	3.7	4.3
Other	107	1.4	1.6
<b>Total</b>	<b>2,667</b>	<b>34.6</b>	<b>40.6</b>

### Health Regions

In WA the number of unique MRSA isolates referred to the Gram-positive Typing Laboratory since 2003/2004 has increased three fold from 2,648 isolates to 7,742 isolates in 2013/2014. During this period there has been a two fold increase in the number of micro-alert C MRSA isolates primarily driven by the introduction and subsequent transmission of ST22-IV [2B] (EMRSA-15) in Western Australian aged care facilities. In the south of the state a small number of ST5-II [2A] (New York Japan/USA 100) isolates continues to be identified which are presumably linked to the outbreak reported in 2006 (1). For micro-alert B MRSA isolates although the number of PVL-negative isolates has increased from 2,000 to 4,000 isolates per year the number of PVL-positive isolates has increased from 0 to approximately 3,000 isolates in 2013/2014. Of concern has been the dramatic increase of PVL-positive isolates in the Kimberley and Pilbara health regions including the emergence of the multi-resistant ST772-V [5C2] (Bengal Bay MRSA), the trimethoprim resistant ST5-IV [2B] (WA 121), the gentamicin resistant ST22-IV [2B], and ST8-IV [2B] (USA300).

## 4. Introduction

In Western Australia (WA) methicillin-resistant *Staphylococcus aureus* (MRSA) is a notifiable condition and as per the Western Australian Department of Health operational directive (*OP0478/13 Infection Prevention and Control of Methicillin-resistant Staphylococcus aureus [MRSA] in Western Australian Healthcare Facilities*) medical microbiology laboratories are required to refer all non environmental isolates to the PathWest Gram-positive Typing Laboratory at Fiona Stanley Hospital for strain characterisation.

Isolates are characterised as:

- Micro-alert C MRSA. The clone type is identified
- Micro-alert B Panton Valentine leucocidin (PVL)-negative MRSA
- Micro-alert B PVL-positive MRSA. The clone type is identified

Micro-alert C strains include all healthcare-associated MRSA (HA-MRSA) (e.g. ST22-IV [2B] colloquially known as EMRSA-15) and those community-associated MRSA (CA-MRSA) strains with increased virulence or transmissibility of antimicrobial resistance as determined by the WA Multi-Resistant Organism Expert Advisory Group (e.g. ST8-IV [USA300] and ST772-V [Bengal Bay MRSA]). Micro-alert B strains include CA-MRSA.

Based on the strain type and type of micro-alert assigned (i.e. micro-alert B or C) and on the specific setting a risk assessment is made by the healthcare facility in the management of MRSA-positive patients.

## 5. MRSA Isolated in Western Australia, July 2013 to June 2014

From July 1 2013 to June 30 2014, 9,576 MRSA were referred to the PathWest Gram-positive Typing Laboratory (a 14.5% increase from the 8,358 MRSA referred in 2012/2013). Unique isolate data (n = 7,741), ie duplicate isolates excluded, are presented in this report (Table 1). A duplicate isolate is defined as an isolate with an identical phenotype to an isolate received from the same patient within the previous 12 months.

**Table 1: Unique isolates of MRSA in Western Australia, July 2013 to June 2014**

	Patient Isolates n = 7,659 (98.9%)		HCW isolates n = 82 (1.1%)		
MRSA	Clinical	Screen	Clinical	Screen	n (%)
HA-MRSA	689	330	0	20	1,039 (13.4%)
CA-MRSA PVL-positive	2,671	128	6	5	2,810 (36.3%)
CA-MRSA PVL-negative	3,011	830	1	50	3,892 (50.3%)
<b>Total</b>	<b>6,371</b>	<b>1,288</b>	<b>7</b>	<b>75</b>	<b>7,741</b>

HA-MRSA: Healthcare-associated MRSA; CA-MRSA: community-associated MRSA; PVL: Panton-Valentine leucocidin; HCW: Healthcare worker

## 6. MRSA Nomenclature

Since July 2003, the PathWest Gram-positive Typing Laboratory has employed the international MRSA nomenclature system described by Dr Mark Enright *et al* (18). This system provides a universally standardised MRSA nomenclature allowing MRSA clones to be readily compared between laboratories. It is based upon the combination of seven housekeeping genes sequence types (STs) using multilocus sequence typing (MLST) and the SCC*mec* type using multiplex PCR. The MRSA genotype is therefore the sum of the SCC*mec* type and the type of its recipient chromosome. For example, an MRSA clone of ST22 and SCC*mec* type IV [2B] is referred to as ST22-IV [2B].

## 7. Micro-Alert C MRSA

Of the 7,741 unique isolates referred to the PathWest Gram-positive Typing Laboratory in 2013/2014, 1,165 (15.1%) were identified as micro-alert C MRSA (Table 2).

**Table 2: Micro-alert C MRSA in Western Australia, July 2013 to June 2014**

MLST-SCC <i>mec</i>	Clone	Patient Isolates 1,144 (98.2%)		HCW isolates 21 (1.8%)		Total
		Clinical	Screen	Clinical	Screen	
HA-MRSA						
ST22-IV [2B] <sup>a</sup>	EMRSA-15	626	312	0	16	954
ST22-IV [2B] <sup>b</sup>		45	2	0	4	51
ST239-III [3A]	Aus-2/3 EMRSA	10	10	0	0	20
ST5-II [2A] <sup>c</sup>	New York Japan MRSA/USA100	8	4	0	0	12
ST8-VI [4B]	Irish 2 EMRSA	0	1	0	0	1
ST5-I [1B]	Cordoba EMRSA	0	1	0	0	1
Total HA-MRSA		689	330	0	20	1039
CA-MRSA						
ST8-IV [2B] <sup>d</sup>	USA300	90	9	0	1	100
ST772-V [5C2]	Bengal Bay MRSA	24	2	0	0	26
Total CA-MRSA		114	11	0	1	126
Total Micro-alert C MRSA		803	341	0	21	1,165

<sup>a</sup>PVL negative ST22-IV [2B] (EMRSA-15)

<sup>b</sup>PVL positive ST22-IV [2B]

<sup>c</sup>ST5-II includes two ST764-II [2A] isolates which is a double locus variant of ST5-II [2A]

<sup>d</sup>Three ST8-IV [2B] (USA300) isolates were PVL negative

The average age of patients with a micro-alert C MRSA was 66.6 years (median 77 years) with a significantly lower average recorded for patients with a PVL-positive micro-alert C MRSA (35.7 years [median 30 years]) compared to patients with a



PVL-negative micro-alert C MRSA (74.2 years [median 80 years]) ( $P < 0.0001$ ). The high average age for the PVL negative micro-alert C MRSA patient is a reflection of the dominance of the healthcare associated ST22-IV [2B] (EMRSA-15) clone which has become endemic in Western Australian aged care facilities (19).

## 8. Micro-Alert B MRSA

Of the 7,741 unique isolates referred to the PathWest Gram-positive Typing Laboratory in 2013/2014, 6,576 (84.9%) were identified as micro-alert B MRSA (Table 3).

**Table 3: Micro-alert B MRSA in Western Australia, July 2013 to June 2014**

MLST-SCCmec	Clone	Patient Isolates 6515 (99.1%)		HCW isolates 50 (0.9%)		Total
		Clinical	Screen	Clinical	Screen	
Panton Valentine leucocidin Negative CA-MRSA						
Total PVL Negative		3,027	832	1	49	3,909
Panton Valentine leucocidin Positive CA-MRSA						
ST93-IV [2B]	Queensland	1,690	72	5	1	1,768
ST5-IV [2B]	WA 121	482	23	1	0	506
ST30-IV [2B]	WSPP <sup>a</sup>	269	14	0	3	286
ST59/952-V [5C2&5]	Taiwan/A	44	4	0	0	48
ST923-IV [2B]	WA 62	32	3	0	0	35
ST59-IV [2B]	WA 55	12	1	0	0	13
ST80/583/728-IV [2B]	European/A/B MRSA	10	0	0	0	10
ST1-IV [2B]	WA 1	7	1	0	0	8
ST30-V [5C2]	WA 124	6	0	0	0	6
ST6-IV [2B]	WA 51	4	0	0	0	4
ST1232-V [5C2]		4	0	0	0	4
ST78-IV [2B]	WA 2	2	0	0	1	3
ST5-IV [2B]	WA 64	3	0	0	0	3
ST5-IV [2B]	WA 3	1	0	0	0	1
ST88-V [5C2]	WA 117	1	0	0	0	1
ST1930-IV [2B]	WA 119	1	0	0	0	1
ST1420-IV [2B]	WA 126	1	0	0	0	1
ST1-V [5C2&5]	WA 137	2	0	0	0	2
Total PVL Positive		2,541	115	6	5	2,667
Total Micro-Alert B MRSA		5,568	947	7	54	6,576

<sup>a</sup>WSPP = Western Samoan Phage Pattern, also known as South Western Pacific (SWP) clone, also known as Oceanic clone



The average age of patients with a micro-alert B MRSA was 39.1 years (median 35 years) with a significantly lower average recorded for patients with a PVL-positive micro-alert B MRSA (26.6 years [median 24 years]) compared to patients with a PVL-negative micro-alert B MRSA (49.8 years [median 51 years]) ( $P < 0.0001$ ).

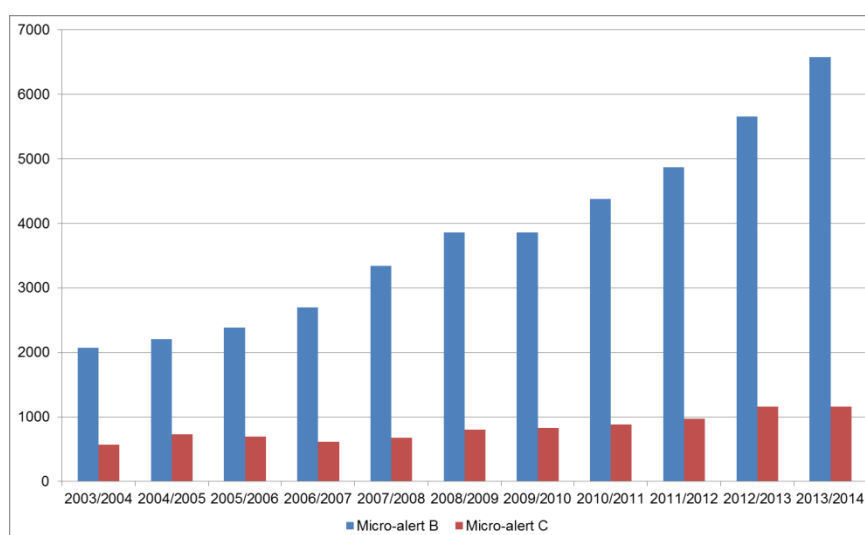
A significant difference in the mean ages of micro-alert C and micro-alert B infected patients was also identified ( $P < 0.0001$ ). This was primarily due to the predominance of ST22-IV [2B] (EMRSA-15) and PVL –positive CA-MRSA in micro-alert C and micro-alert B patients respectively.

## 9. Micro-Alert C versus Micro-Alert B MRSA Clones

Since 2003/2004 the number of unique isolates of MRSA referred to the Gram-positive Typing laboratory has increased almost three-fold from 2,879 to 7,741 (Figure 1).

Although the increase has been primarily been due to the increasing number of micro-alert B MRSA (2073 in 2003/2004 to 6,576 in 2013/2014) there has also been an increase in micro-alert C MRSA isolates (575 in 2003/2004 to 1,165 in 2013/2014). The increase in micro-alert C MRSA has primarily been due to ST22-IV [2B] (EMRSA-15), a healthcare-associated MRSA (HA-MRSA) predominately found in Western Australian long term care facility patients and in healthcare workers from the United Kingdom and Ireland (19, 20)

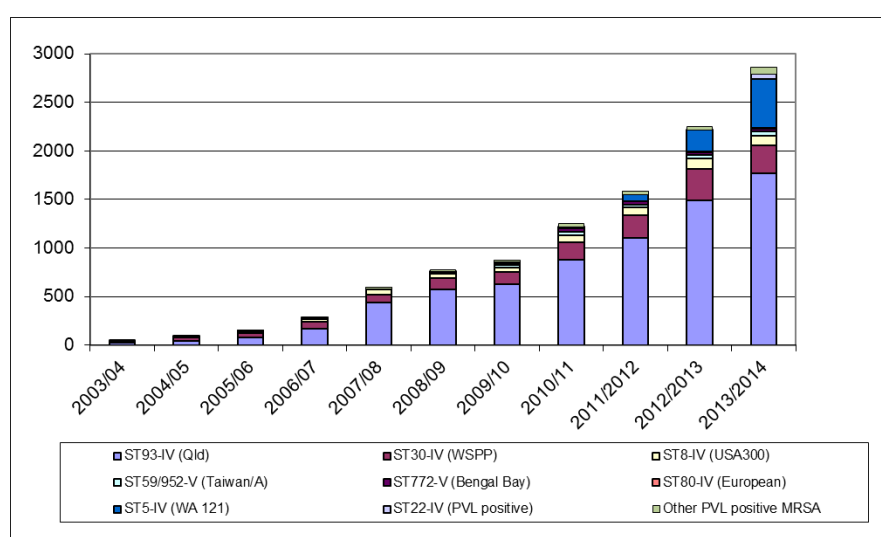
**Figure 1: Annual number of referred isolates of MRSA in Western Australia, 2003/2004 to 2013/2014**



In contrast to the micro-alert C HA-MRSA clones, the non-Western Australian community-associated MRSA (CA-MRSA) clones have emerged from diverse genetic backgrounds and frequently harbour the genes expressing PVL (19, 20).

In WA, although the vertical and horizontal transmission of SCC*mec* elements into *S. aureus* has also occurred on multiple occasions, only a small number of clones have successfully adapted to the Western Australian community environment (3). Furthermore these clones typically lack the PVL-associated genes. Recently however, several PVL-positive clones have been identified in WA, including ST93-IV [2B], known colloquially as “Queensland CA-MRSA”. First described in the early 2000s in Queensland (21), ST93-IV [2B] has become the dominant PVL-positive CA-MRSA clone in WA (Figure 2). In addition to ST93-IV [2B] several international PVL-positive MRSA have been identified in WA including: ST30-IV [2B] (SWP MRSA), ST22-IV [2B], ST8-IV [2B] (USA 300), ST772-V [5C2] (Bengal Bay MRSA), ST59-V [5C2 & 5] (Taiwan MRSA) and ST80-IV (European MRSA). ST22-IV [2B], ST8-IV [2B] (USA300) and ST772-V [5C2] (Bengal Bay MRSA) have been reported to cause single strain hospital outbreaks and therefore have been classified as a micro-alert C MRSA (22-25).

**Figure 2: Annual number of referred isolates of PVL-positive MRSA in Western Australia, 2003/2004 to 2013/2014**



As PVL-positive MRSA are known to cause severe skin and soft tissue infections that often require hospitalisation in young otherwise healthy people, the increasing percentage of MRSA isolated in WA identified as PVL positive is a public health concern (Figure 3). Of particular concern has been the rapid emergence of PVL-positive MRSA in the state’s north-west, particularly amongst the aboriginal populations. In the Kimberley and Pilbara regions, in addition to ST93-IV [2B], which in 2013/2014 was identified in 1,202 and 184 per 100,000 population respectively, PVL-positive ST5-IV [2B] (WA 121) has recently emerged and was identified in 677 and 140 per 100,000 population respectively (Tables 4 and 5).

**Figure 3: Annual percentage of referred isolates MRSA identified as PVL-positive MRSA in Western Australia, 2003/2004 to 2013/2014**

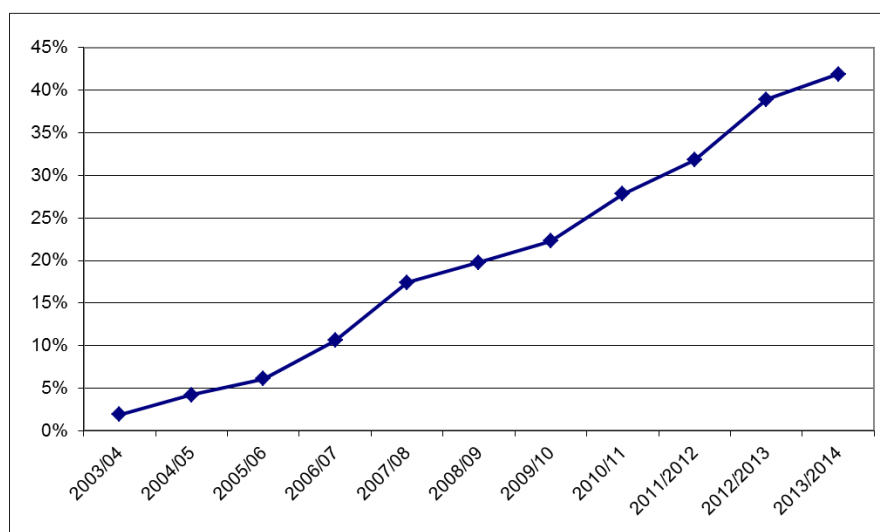


Table 4: New MRSA cases notified to Department of Health by Health Region according to postcode of residence, July 2013 to June 2014

		Health Region									
MLST/SCCmec	PFGE	Kimb	Pilb	Midw	Gold	Wheat	Metro	SthW	GSth	Not WA	Total
<b>Micro-alert C Clones</b>											
ST22-IV[2B]	EMRSA-15, PVL negative	3	6	10	21	10	872	17	12	2	953
ST22-IV[2B]	EMRSA-15, PVL positive	9	0	0	0	0	40	1	1	0	51
ST239-III[3A]	Aus-2/3 EMRSA, PVL negative	3	3	0	1	0	6	3	1	3	20
ST5-II[2A]	New York/Japan MRSA, PVL negative	0	0	1	0	0	4	0	5	0	10
ST8-IV[2B]	USA300, PVL positive	5	0	0	3	1	76	6	1	8	100
ST772-V[5C2]	Bengal Bay Clone, PVL positive	1	0	1	0	0	19	1	1	3	26
Other		0	0	0	0	0	5	0	0	0	5
<b>Total Micro-alert C Clones</b>		<b>21</b>	<b>9</b>	<b>12</b>	<b>25</b>	<b>11</b>	<b>1022</b>	<b>28</b>	<b>21</b>	<b>16</b>	<b>1165</b>
<b>Micro-alert B Clones</b>											
ST93-IV[2B]	Qld Clone, PVL positive	550	114	164	49	71	696	62	29	33	1768
ST5-IV[2B]	WA MRSA-121, PVL positive	310	87	27	11	6	59	3	1	2	506
ST30-IV[2B]	WSPP MRSA, PVL positive	26	15	6	10	4	196	13	4	11	285
Other		316	113	230	146	130	2703	249	93	37	4017
<b>Total Micro-alert B Clones</b>		<b>1202</b>	<b>329</b>	<b>427</b>	<b>216</b>	<b>211</b>	<b>3654</b>	<b>327</b>	<b>127</b>	<b>83</b>	<b>6576</b>
<b>Total MRSA</b>		<b>1223</b>	<b>338</b>	<b>439</b>	<b>241</b>	<b>222</b>	<b>4676</b>	<b>355</b>	<b>148</b>	<b>99</b>	<b>7741</b>

Kimb = Kimberley, Pilb = Pilbara, Midw = Midwest, Gold = Goldfields, Wheat = Wheatbelt, Metro = Metropolitan Perth, SthW = South West, GSth – Great Southern, Not WA = Outside WA. MLST/SCCmec types may have multiple PFGE pulsotypes.

Table 5: MRSA notification rates per 100,000 population by Health Region according to postcode of residence, July 2013 to June 2014

		Health Region								
MLST/SCCmec	PFGE	Kimb	Pilb	Midw	Gold	Wheat	Metro	SthW	GSth	WA
<b>Micro-alert C Clones</b>										
ST22-IV[2B]	UK EMRSA-15, PVL negative	6.6	9.7	14.4	36.0	11.8	44.0	9.0	17.7	37.3
ST22-IV[2B]	UK EMRSA-15, PVL positive	19.7					2.0	0.5	1.5	2.0
ST239-III[3A]	Aus-2/3 EMRSA, PVL negative	6.6	4.8		1.7		0.3	1.6	1.5	0.8
ST5-II[2A]	New York/Japan MRSA, PVL negative			1.4			0.2		7.4	0.4
ST8-IV[2B]	USA300, PVL positive	10.9			5.2	1.2	3.8	3.2	1.5	3.9
ST772-V[5C2]	Bengal Bay Clone, PVL positive	2.2		1.4			1.0	0.5	1.5	1.0
Other							0.2			0.2
<b>Total Micro-alert C Clones</b>		<b>45.9</b>	<b>14.5</b>	<b>17.3</b>	<b>42.9</b>	<b>12.9</b>	<b>51.6</b>	<b>14.8</b>	<b>31.0</b>	<b>45.6</b>
<b>Micro-alert B Clones</b>										
ST93-IV[2B]	Qld Clone, PVL positive	1201.8	184.0	235.9	84.1	83.6	35.2	32.7	42.9	69.1
ST5-IV[2B]	WA MRSA-121, PVL positive	677.4	140.4	38.8	18.9	7.1	3.0	1.6	1.5	19.8
ST30-IV[2B]	WSPP MRSA, PVL positive	56.8	24.2	8.6	17.2	4.7	9.9	6.9	5.9	11.1
Other		690.5	182.4	330.9	250.6	153.1	136.5	131.4	137.5	157.1
<b>Total Micro-alert B Clones</b>		<b>2626.5</b>	<b>531.1</b>	<b>614.3</b>	<b>370.8</b>	<b>248.5</b>	<b>184.6</b>	<b>172.6</b>	<b>187.7</b>	<b>257.2</b>
<b>Total MRSA</b>		<b>2672.4</b>	<b>545.6</b>	<b>631.5</b>	<b>413.7</b>	<b>261.4</b>	<b>236.2</b>	<b>187.3</b>	<b>218.8</b>	<b>302.7</b>

Kimb = Kimberley, Pilb = Pilbara, Midw = Midwest, Gold = Goldfields, Wheat = Wheatbelt, Metro = Metropolitan Perth, SthW = South West, GSth = Great Southern, UD = Undetermined

Population figures (2014 - projected) obtained from Epidemiology Branch, Department of Health A.

## 10. Significant Micro-Alert C Clones

### 10.1. ST22-IV [2B] (EMRSA-15) – PVL NEGATIVE

Initially introduced into WA in 1997 by overseas healthcare workers (20), ST22-IV [2B] (EMRSA-15) has become the dominant Micro-Alert C MRSA clone isolated in WA accounting for 12.3% of MRSA and 81.8% of micro-alert C MRSA. Globally ST22-IV [2B] (EMRSA-15) is one of the most predominant healthcare-associated MRSA clones (10)

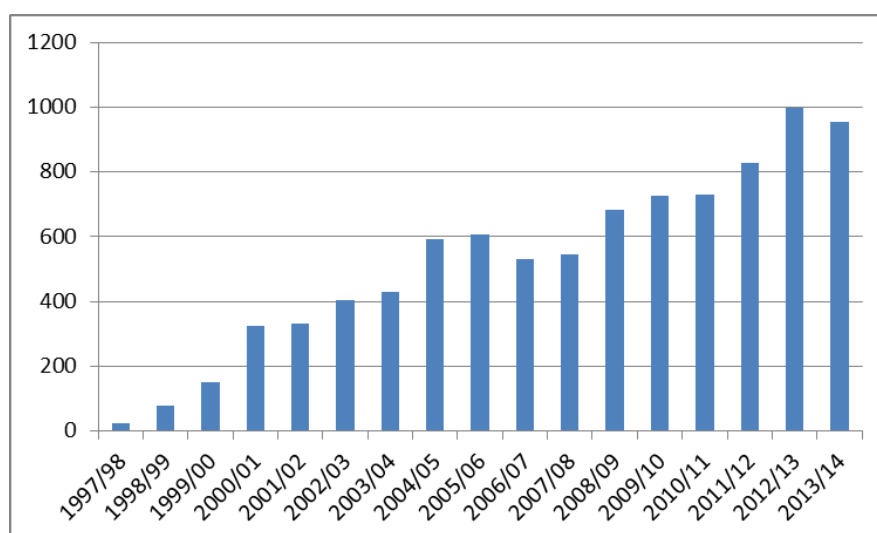
**Phenotypic Features:** Typically urease negative ciprofloxacin resistant. Approximately 50% of isolates were also erythromycin resistant.

**Western Australian Notification Rate:** 37.27 per 100,000 (Table 5).

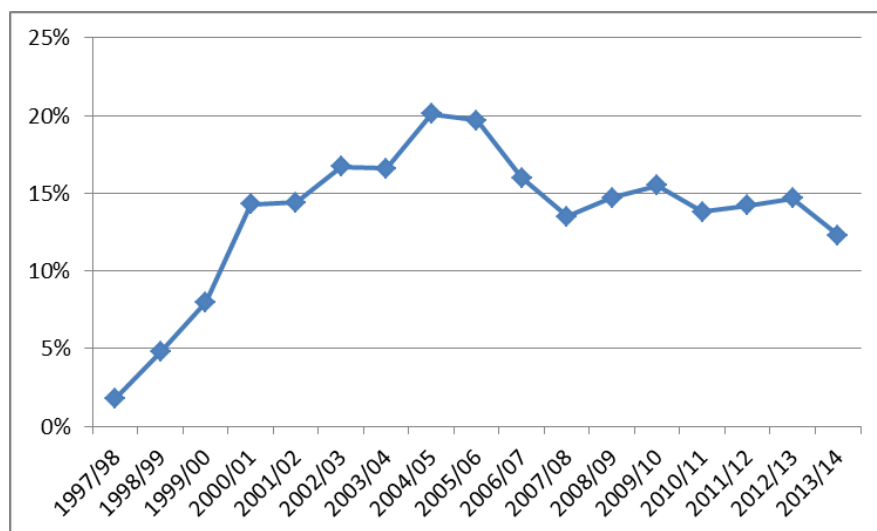
**Geographic Distribution:** Although isolated in all health regions, 91.5% of isolates were from patients/healthcare workers residing in the Perth metropolitan area (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST22-IV [2B] (EMRSA-15) was 73 years (median 80 years); a reflection of the frequent isolation of ST22-IV [2B] from patients residing in aged care facilities.

**Figure 4: Annual number of referred isolates of PVL-negative ST22-IV [2B] (EMRSA-15) in Western Australia, July 1997 to June 2014**



**Figure 5: PVL-negative ST22-IV [2B] (EMRSA-15) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



## 10.2. ST22-IV [2B] – PVL POSITIVE

Although PVL-positive ST22-IV [2B] shares the same MLST sequencing housekeeping genes as PVL-negative ST22-IV [2B] (EMRSA-15) the two clones are genetically distinct. PVL-positive ST22-IV [2B] was first isolated in WA from an Indian healthcare worker employed in a long term care facility. In 2013/2014 PVL-positive ST22-IV [2B] accounted for 0.7% of MRSA and 4.4% of micro-alert C MRSA. Internationally PVL-positive ST22-IV [2B] has been reported to cause hospital single strain outbreaks (24).

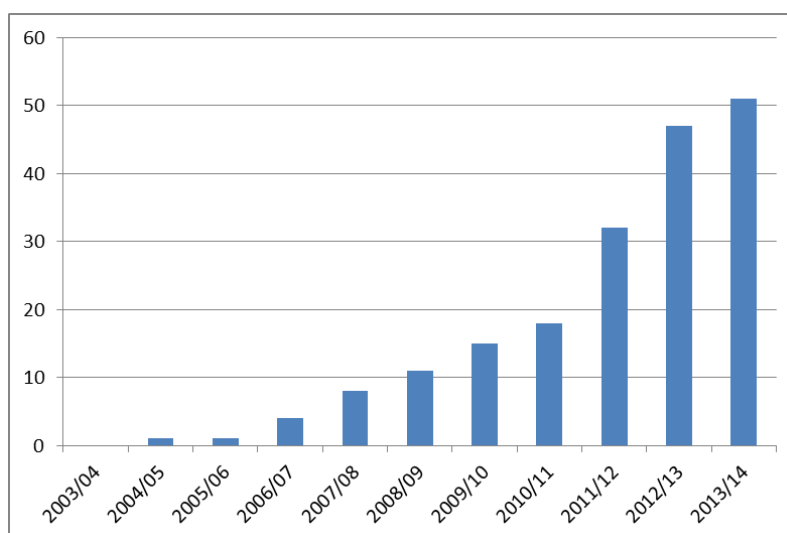
**Phenotypic Features:** Typically urease negative, gentamicin resistant. Approximately 75% and 40% of isolates were ciprofloxacin and erythromycin resistant respectively.

**Western Australian Notification Rate:** 1.99 per 100,000 (Table 5)

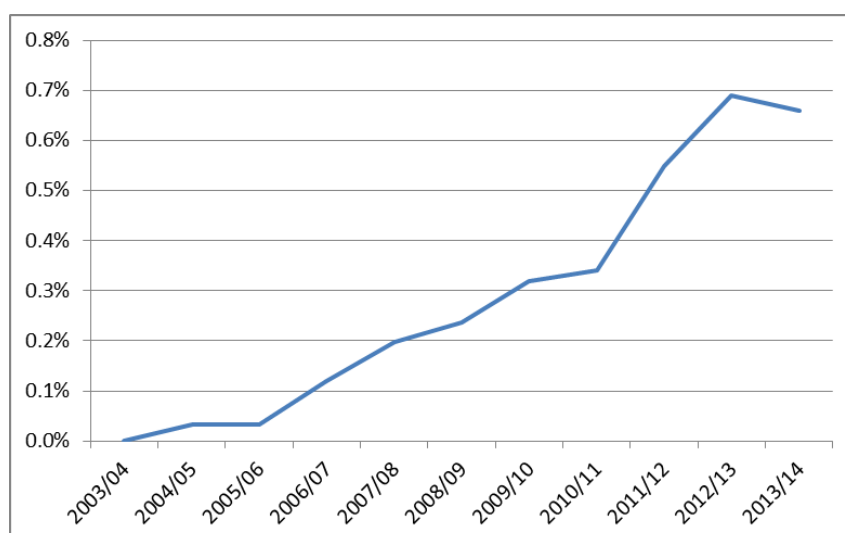
**Geographic Distribution:** Although in 2013/2014 most isolates were from the Perth metropolitan region, PVL-positive ST22-IV was also isolated in the South West, Great Southern and Kimberley regions (Table 4). In the Kimberley the notification rate was 19.7 per 100,00.

**Patient Age:** The mean age of patients infected/colonised with ST22-IV was 34 years (median 29 years) which is significantly younger than the mean age of patients infected with PVL-negative ST22-IV (EMRSA-15) ( $P < 0.001$ )

**Figure 6: Annual number of referred isolates of PVL-positive ST22-IV [2B] in Western Australia, July 1997 to June 2014**



**Figure 7: PVL-positive ST22-IV [2B] as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**





### 10.3. ST239-III [3A] (Aus-2/3 EMRSA)

ST239-III [3A] has been a predominant healthcare associated MRSA clone in most Australian states since the early 1980s (2). The “search and destroy” MRSA policy implemented by the WA Health Department in 1982 has prevented ST239-III [3A] from becoming established in Western Australian hospitals. In 2013/2014 ST239-III [3A] accounted for 0.3% of MRSA and 1.7% of micro-alert C MRSA.

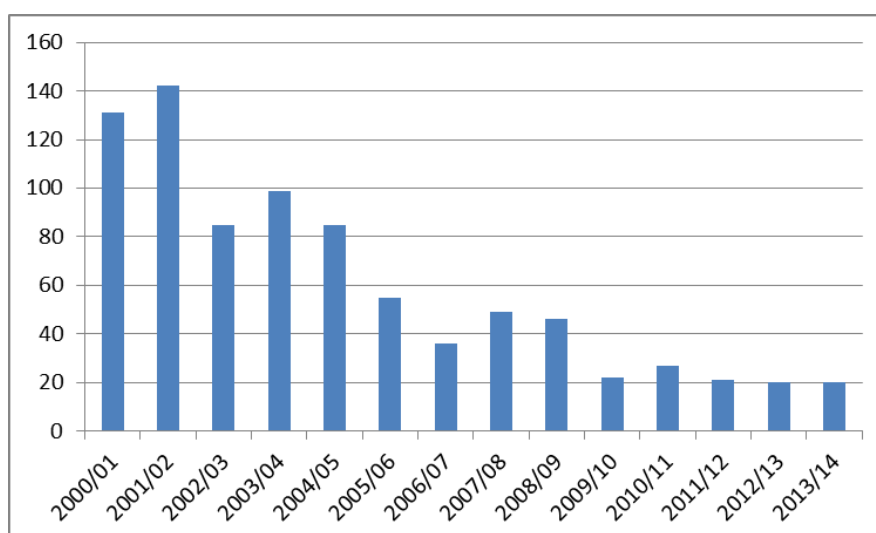
**Phenotypic Features:** Typically urease positive erythromycin, tetracycline, trimethoprim, gentamicin and ciprofloxacin resistant.

**Western Australian Notification Rate:** 0.78 per 100,000 (Table 5).

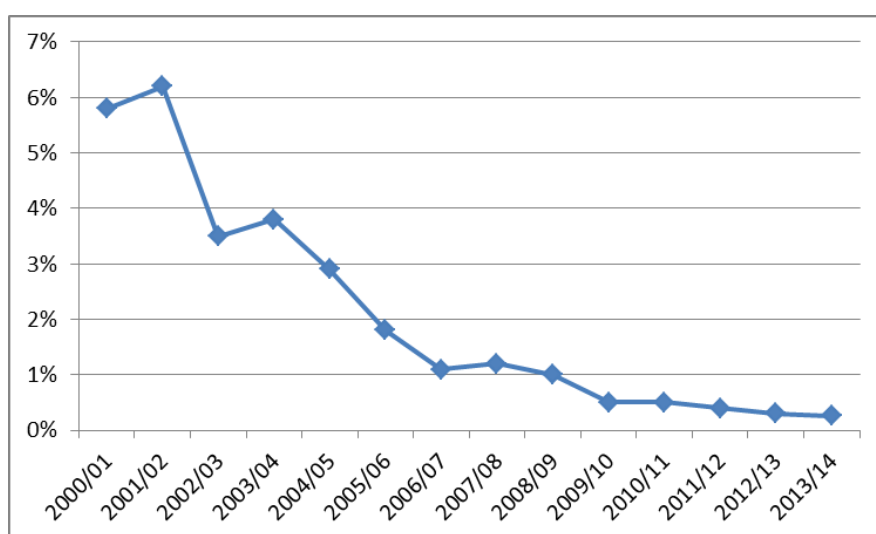
**Geographic Distribution:** In 2013/2014 a small number of isolates were identified in most health regions (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST239-III was 63 years (median 64 years).

**Figure 8: Annual number of referred isolates of ST239-III [3A] (Aus-2/3 EMRSA) in Western Australia, July 1997 to June 2014**



**Figure 9: ST239-III [3A] (Aus-2/3 EMRSA) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



#### 10.4. ST5-II [2A] (New York Japan MRSA/USA100)

ST5-II [2A] is the predominant healthcare associated MRSA in the Japan and the USA (4). A single strain outbreak of ST5-II [2A] was identified in the South West region of WA in 2005 (4). The index case was as a colonised healthcare worker who had previously been hospitalised in New York. By having a state-wide MRSA policy, the outbreak was able to be managed and controlled by the WA Health Department. In 2013/2014 ST5-II [2A] accounted for 0.1% of MRSA and 0.9% of micro-alert C MRSA.

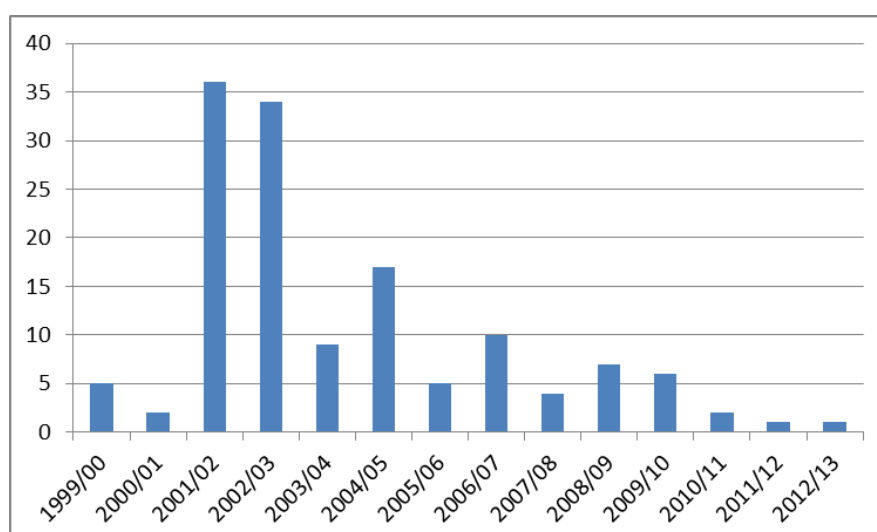
**Phenotypic Features:** Typically urease positive and ciprofloxacin and erythromycin resistant.

**Western Australian Notification Rate:** 0.39 per 100,000 (Table 5).

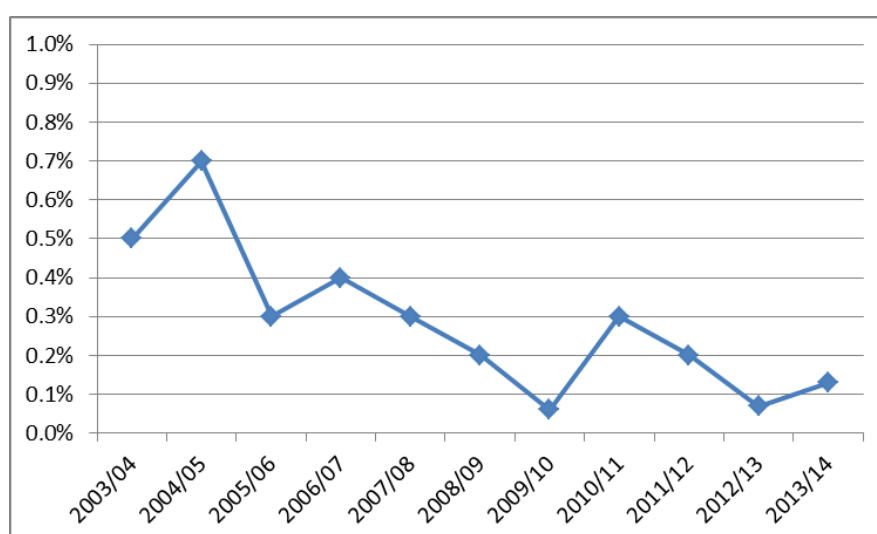
**Geographic Distribution:** In 2013/2014 a small number of isolates were identified in the Perth metropolitan, Great Southern and Midwest regions (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST5-II [2A] was 70 years (median 64 years).

**Figure 10: Annual number of referred isolates of ST5-II [2A] (New York Japan MRSA/USA100) in Western Australia, July 1997 to June 2014**



**Figure 11: ST5-II [2A] (New York Japan MRSA/USA100) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



### 10.5. ST8-IV [2B] (USA300)

PVL-positive ST8-IV [2B] (USA300) is the dominant community MRSA strain in North America (26). In recent years ST8-IV [2B] (USA300) has become established in many North American hospitals (22). ST8-IV [2B] (USA300) was first reported in WA in 2003 (7). Recent travel to the USA is frequently reported in patients with a USA300 infection. In 2013/2014 PVL-positive CA-MRSA accounted for 1.3% of MRSA and 8.6% of micro-alert C MRSA.

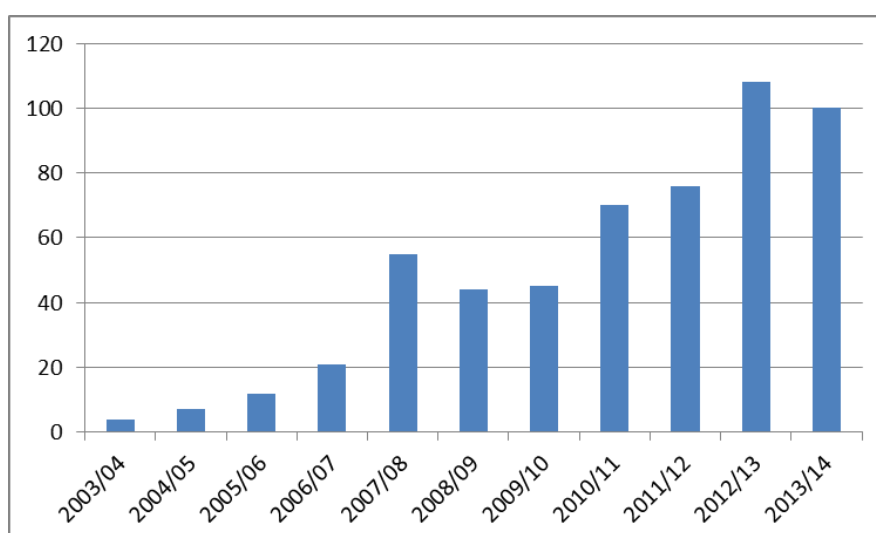
**Phenotypic Features:** ST8-IV [2B] (USA300) is urease positive. Approximately 60% and 70% are ciprofloxacin and erythromycin resistant respectively.

**Western Australian Notification Rate:** 3.91 per 100,000 (Table 5).

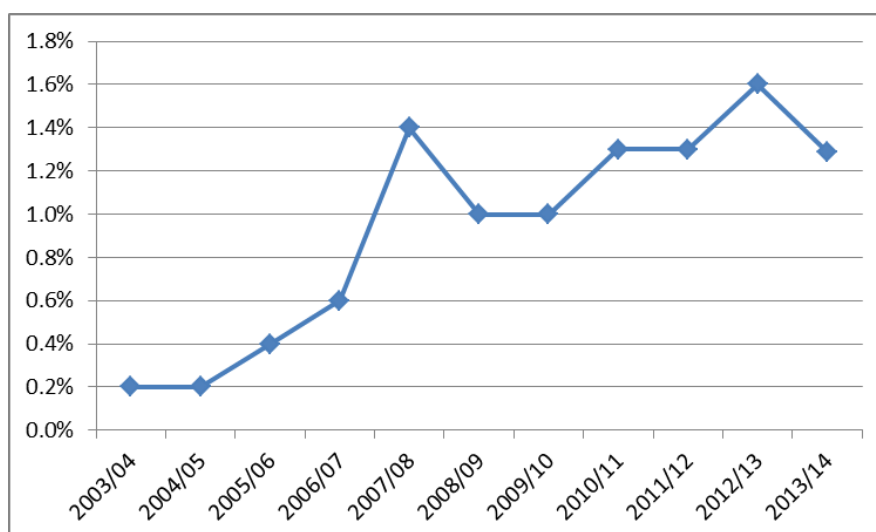
**Geographic Distribution:** In 2013/2014 although predominantly isolated in the Perth Metropolitan region a small number of isolates were identified in most WA health regions (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST8-IV [2B] (USA300) was 36 years (median 30 years).

**Figure 12: Annual number of referred isolates of ST8-IV [2B] (USA300) in Western Australia, July 1997 to June 2014**



**Figure 13: ST8-IV [2B] (USA300) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



## 10.6. ST772-V [5C2] (Bengal Bay MRSA)

PVL-positive ST772-V [5C2] (Bengal Bay) is a multiresistant PVL-positive MRSA first reported in Bangladesh, and subsequently in India, Malaysia and several European countries (25, 27-33). In Europe ST772-V [5C2] has been associated with single strain outbreaks in long term care facilities and in a neonatal intensive care unit. ST772-V [5C2] was first identified in WA in 2007 and was associated with a healthcare worker from the subcontinent. Recent travel to, or residents from the subcontinent is frequently reported in patients with a ST772-V [5C2] infection. In 2013/2014 ST772-V [5C2] accounted for 0.3% of MRSA and 2.2% of micro-alert C MRSA.

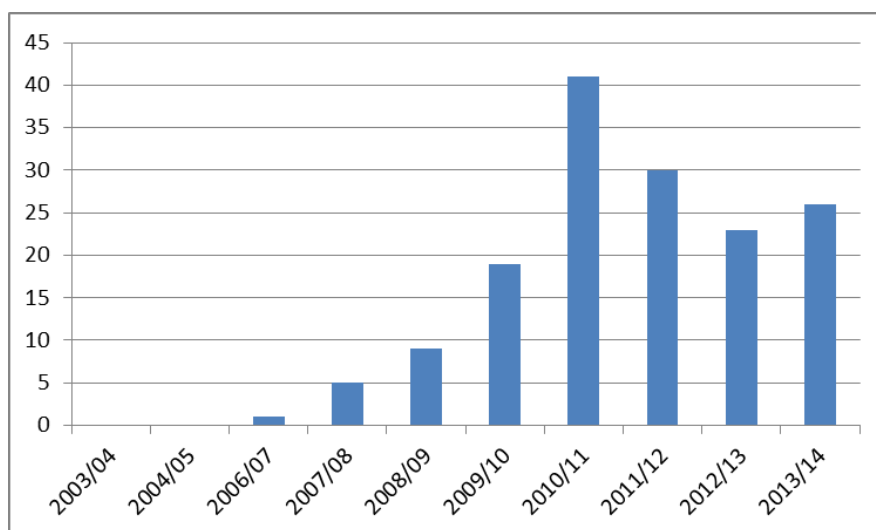
**Phenotypic Features:** Typically urease positive and erythromycin, trimethoprim, gentamicin and ciprofloxacin resistant.

**Western Australian Notification Rate:** 1.02 per 100,000 (Table 5).

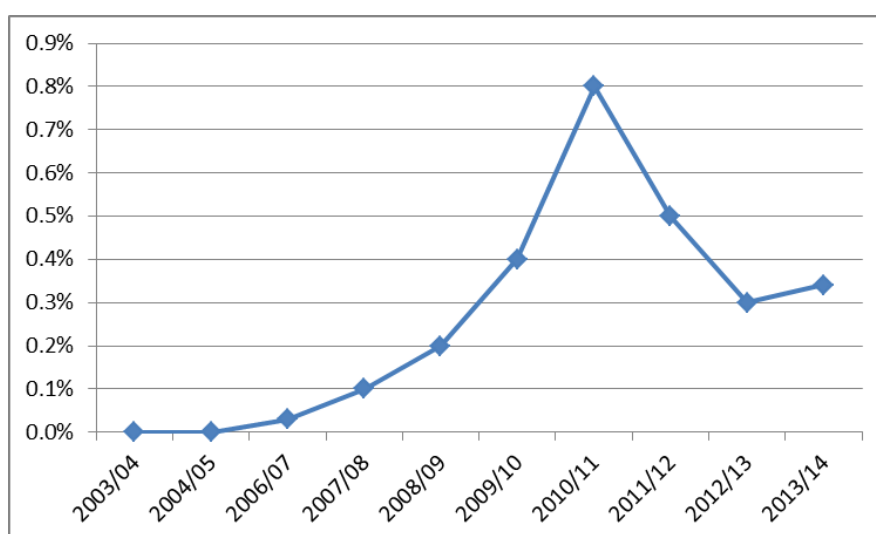
**Geographic Distribution:** In 2013/2014 although predominantly isolated in the Perth Metropolitan region a small number of isolates were identified in most health regions (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST772-V [5C2] was 31 years (median 29 years).

**Figure 14: Annual number of referred isolates of ST772-V [5C2] (Bengal Bay MRSA) in Western Australia, July 1997 to June 2014**



**Figure 15: ST772-V [5C2] (Bengal Bay MRSA) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



## 11. Significant PVL-Positive Micro-Alert B Clones

### 11.1. ST93-IV [2B] (Queensland CA-MRSA)

ST93-IV [2B] (Queensland CA-MRSA), initially identified Ipswich, Queensland in the Caucasian population in 2000 (21), has become the dominant community associated MRSA in Australia (34). Although ST93-IV [2B] was not detected in WA until 2001, PVL-positive ST93 MSSA was identified as the most prevalent *S. aureus* lineage in WA's remote indigenous communities in the mid 1990s (6). In 2013/2014 ST93-IV [2B] accounted for 22.8% of MRSA and 26.9% of micro-alert B MRSA.

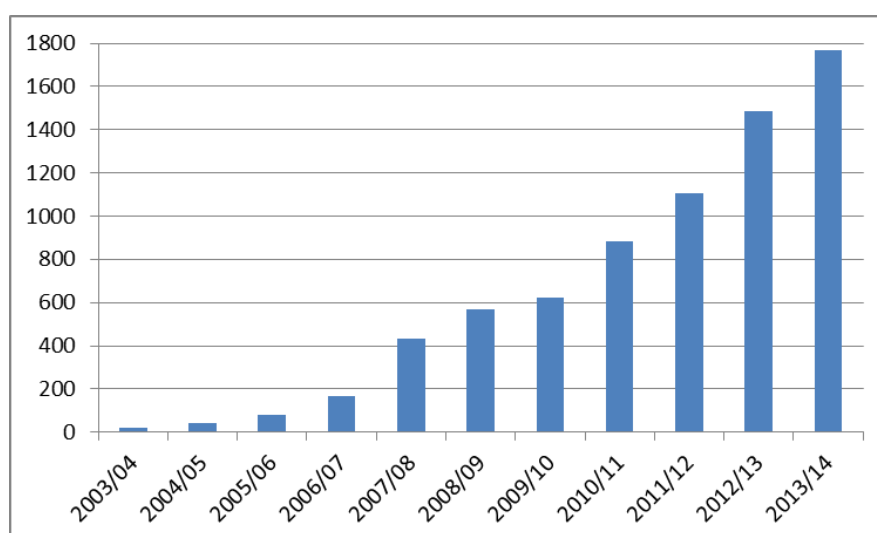
**Phenotypic Features:** Typically urease positive and susceptible to the non  $\beta$ -lactam antimicrobials.

**Western Australian Notification Rate:** 69.14 per 100,000 (Table 5).

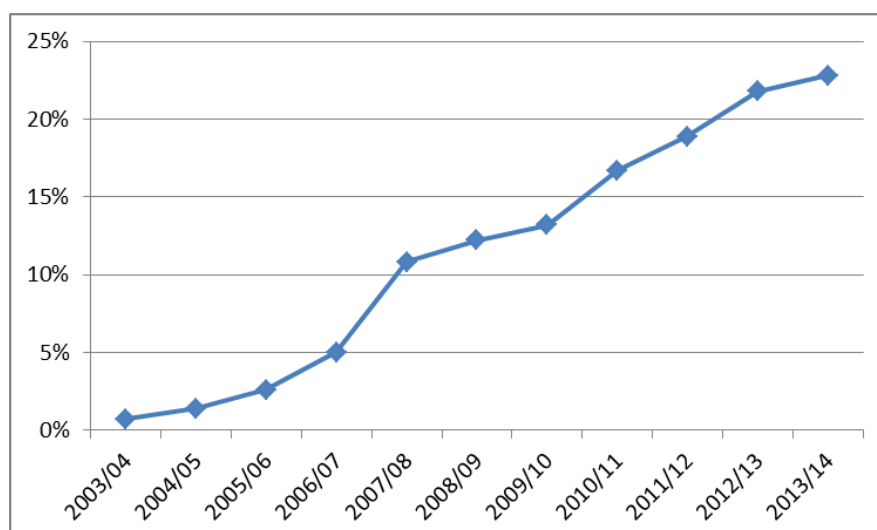
**Geographic Distribution:** In 2013/2014 ST93-IV [2B] was frequently isolated in all WA health regions, with greater than 180 per 100,000 notifications reported in the Kimberley, Pilbara and Midwest (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST93-IV [2B] was 26 years (median 24 years).

**Figure 16: Annual number of referred isolates of ST93-IV [2B] (Queensland CA-MRSA) in Western Australia, July 1997 to June 2014**



**Figure 1: ST93-IV [2B] (Queensland CA-MRSA) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



## 11.2. ST5-IV [2B] (WA 121)

ST5-IV [2B] (WA 121) was initially isolated in 2010 from an abdominal abscess in a 62 year old non-aboriginal male patient living in the Kimberley region. However the majority of patients with WA 121 are young Aboriginal patients living in the Kimberley and Pilbara regions. Unlike other Western Australian clonal cluster 5 MRSA clones, ST5 [2B] (WA 121) carries the *edinA* epidermal cell differentiation inhibitor gene and a type IVc *SCCmec* element; a *SCCmec* subtype rarely identified in WA community-associated MRSA suggesting ST5-IV [2B] (WA 121) has been imported into WA. In 2013/2014 ST5-IV (WA 121) accounted for 6.5% of MRSA and 7.7% of micro-alert B MRSA.

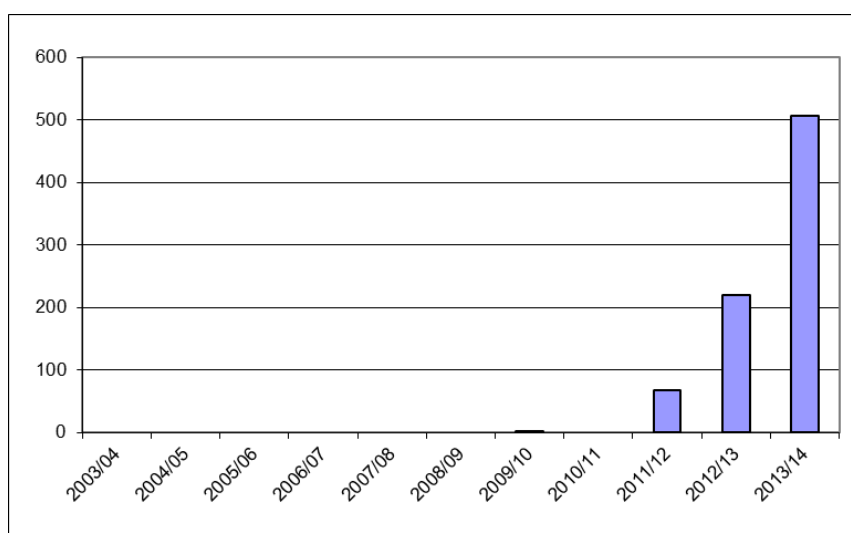
**Phenotypic Features:** Typically urease positive and trimethoprim resistant.

**Western Australian Notification Rate:** 19.79 per 100,000 (Table 5).

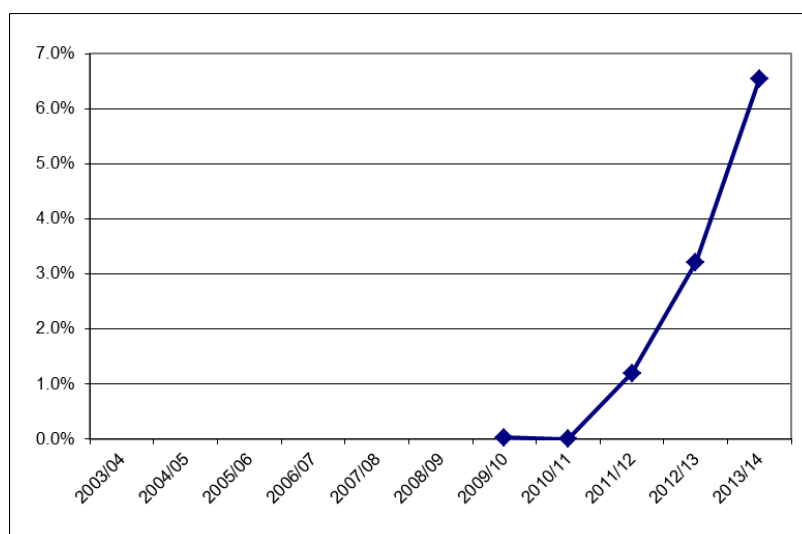
**Geographic Distribution:** In 2013/2014 although isolated in all WA health regions, ST5-IV (WA 121) was primarily isolated in the Kimberley and Pilbara regions with greater than 310 and 87 notifications per 100,00 population (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST5-IV [2B] (WA 121) was 22 years (median 17 years).

**Figure 17: Annual number of referred isolates of ST5-IV [2B] (WA 121) in Western Australia, July 1997 to June 2014**



**Figure 16: ST5-IV [2B] (WA 121) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**



### 11.3. ST30-IV [2B] (WSPP MRSA)

ST30-IV [2B], also known as the Western Samoan Phage Pattern (WSPP) MRSA, South West Pacific (SWP) or Oceania MRSA was first identified in Australia in 1997 in Polynesian patients residing on the east coast presenting with furunculosis (34-36). ST30-IV was initially isolated in WA in 2003 (19). In 2013/2014 ST30-IV accounted for 3.7% of MRSA and 4.3% of micro-alert B MRSA.

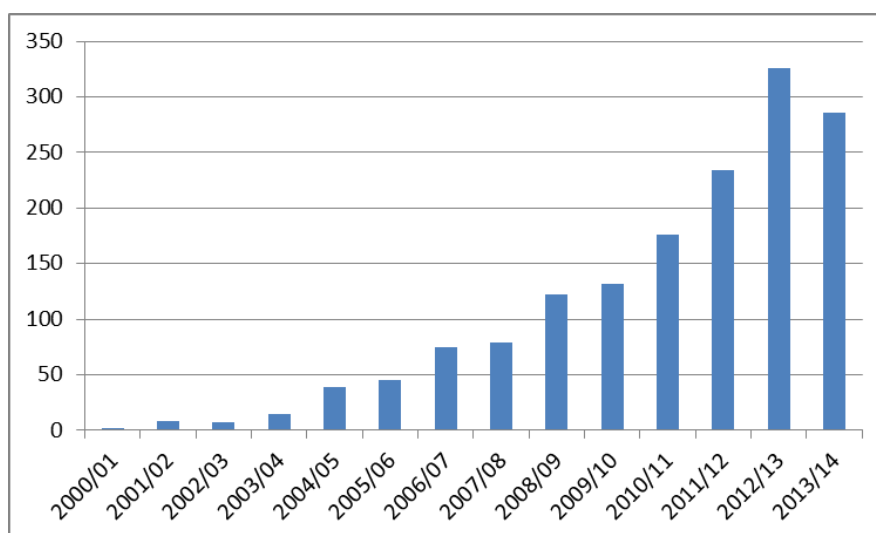
**Phenotypic Features:** Typically urease positive and susceptible to the non  $\beta$ -lactam antimicrobials.

**Western Australian Notification Rate:** 11.14 per 100,000 (Table 5)

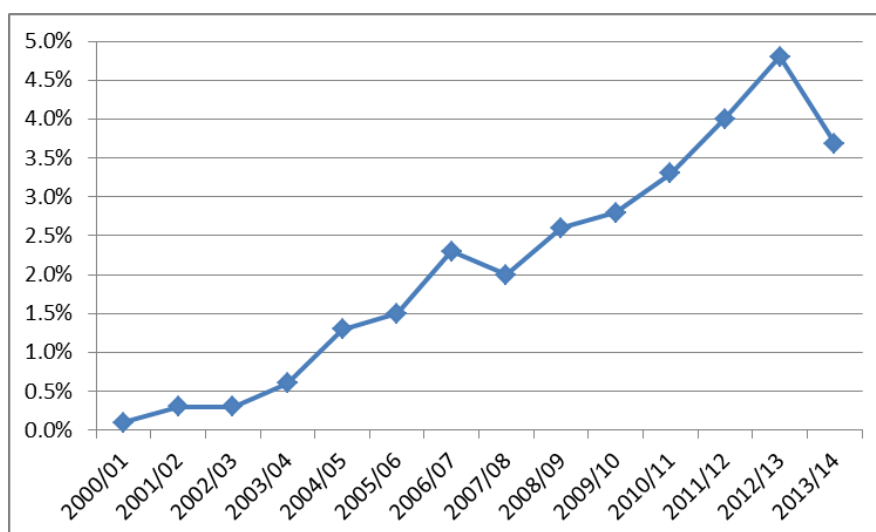
**Geographic Distribution:** In 2013/2014 although isolated in all WA health regions, ST30-IV was primarily isolated in the Perth metropolitan region (Table 4).

**Patient Age:** The mean age of patients infected/colonised with ST30-IV [2B] (WA121) was 35 years (median 34 years).

**Figure 18: Annual number of referred isolates of ST30-IV [2B] (WSPP) in Western Australia, July 1997 to June 2014**



**Figure 19: ST30-IV [2B] (WSPP) as a percentage of the annual number of referred MRSA in Western Australia, July 1997 to June 2014**





## **12. Trend Data, July 1 2003 to June 30 2014**

### **12.1. Western Australia (Figures 20 - 22)**

#### **Micro-alert C**

Twofold increase (575 isolates in 2003/2004 to 1,165 isolates in 2013/2014)  
Increase predominantly due to the transmission of ST22-IV [2B] (EMRSA-15) primarily in aged care nursing homes

#### **Micro-alert B**

Threefold increase (2,073 isolates in 2003/2004 to 6,577 isolates in 2013/2014)  
Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), ST8-IV [2B] (USA300), and ST5-IV (WA 121)

### **12.2. Perth Metropolitan Health Region (Figures 23 - 25)**

#### **Micro-alert C**

Twofold increase (470 isolates in 2003/2004 to 1,022 isolates in 2013/2014)  
Increase predominantly due to the transmission of ST22-IV [2B] (EMRSA-15) primarily in aged care nursing homes

#### **Micro-alert B**

Twofold increase (1,543 isolates in 2003/2004 to 3,655 isolates in 2013/2014)  
Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST8-IV [2B] (USA300)

### **12.3. South West Health Region (Figures 26 - 28)**

#### **Micro-alert C**

27 isolates in 2003/2004 to 28 isolates in 2013/2014

#### **Micro-alert B**

Threefold increase (122 isolates in 2003/2004 to 327 isolates in 2013/2014)  
Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST8-IV [2B] (USA300)

### **12.4. Great Southern Health Region (Figures 29 - 31)**

#### **Micro-alert C**

29 isolates in 2003/2004 to 21 isolates in 2013/2014

#### **Micro-alert B**

Threefold increase (47 isolates in 2003/2004 to 127 isolates in 2013/2014)  
Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST8-IV [2B] (USA300)

### **12.5. Midwest Health Region (Figures 32 - 33)**

#### **Micro-alert C**

15 isolates in 2003/2004 to 12 isolates in 2013/2014

#### **Micro-alert B**

Fivefold increase (83 isolates in 2003/2004 to 427 isolates in 2013/2014)

Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP) and ST5-IV (WA 121)

In 2013/2014 the number of PVL positive and PVL-negative isolates was approximately the same

## **12.6. Central Health Region (Figures 35 - 37)**

### **Micro-alert C**

13 isolates in 2003/2004 to 11 isolates in 2013/2014

### **Micro-alert B**

Fourfold increase (56 isolates in 2003/2004 to 211 isolates in 2013/2014)

Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), ST8-IV [2B] (USA300), and ST5-IV (WA 121)

In 2013/2014 the number of PVL positive and PVL-negative isolates was approximately the same

## **12.6. Goldfields Health Region (Figures 38 - 40)**

### **Micro-alert C**

9 isolates in 2003/2004 to 25 isolates in 2013/2014

### **Micro-alert B**

Fourfold increase (56 isolates in 2003/2004 to 218 isolates in 2013/2014)

Increase in PVL-negative CA-MRSA clones and PVL-positive- ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST5-IV (WA 121)

## **12.7. Pilbara Health Region (Figures 38 - 40)**

### **Micro-alert C**

0 isolates in 2003/2004 to 9 isolates in 2013/2014

### **Micro-alert B**

Fourfold increase (79 isolates in 2003/2004 to 329 isolates in 2013/2014)

Increase in PVL-positive CA-MRSA clones including ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST5-IV (WA 121)

In 2013/2014 the number of PVL positive was twofold more than PVL-negative isolates

## **12.8. Kimberley Health Region (Figures 41 - 43)**

### **Micro-alert C**

4 isolates in 2003/2004 to 21 isolates in 2013/2014

### **Micro-alert B**

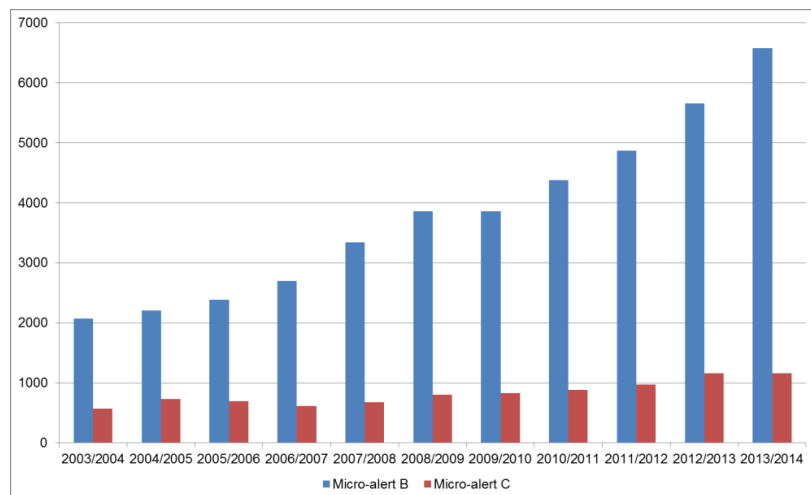
Sixteen fold increase (73 isolates in 2003/2004 to 1,200 isolates in 2013/2014)

Increase in PVL-positive CA-MRSA clones including ST93-IV [2B] (Queensland CA-MRSA), ST30-IV [2B] (WSPP), and ST5-IV (WA 121)

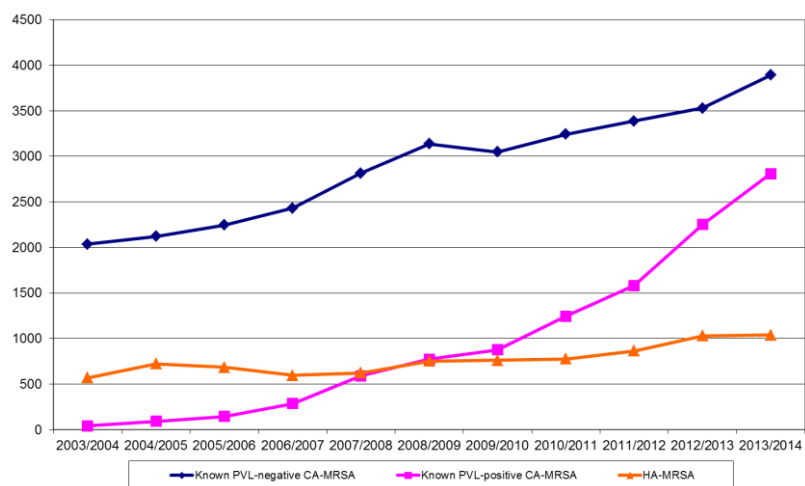
In 2013/2014 the number of PVL positive was threefold more than PVL-negative isolates

## Western Australia

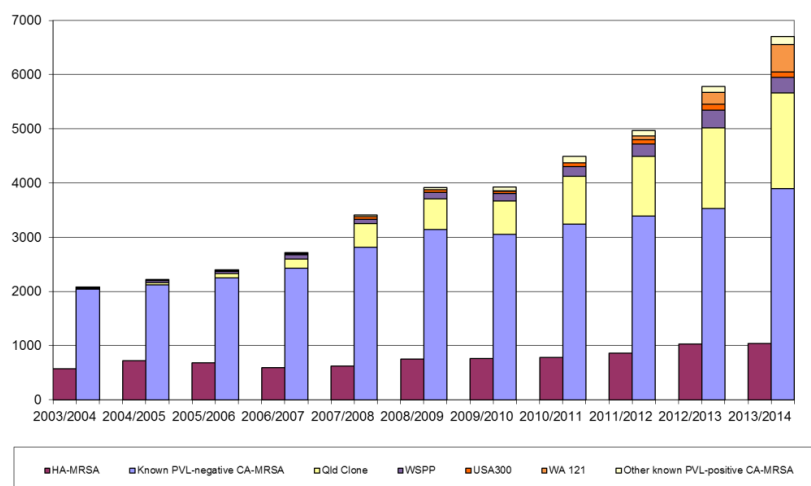
**Figure 20: Annual number of Micro-alert B and Micro-alert C MRSA, Western Australia July 2003 to June 2014**



**Figure 21: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Western Australia July 2003 to June 2014**

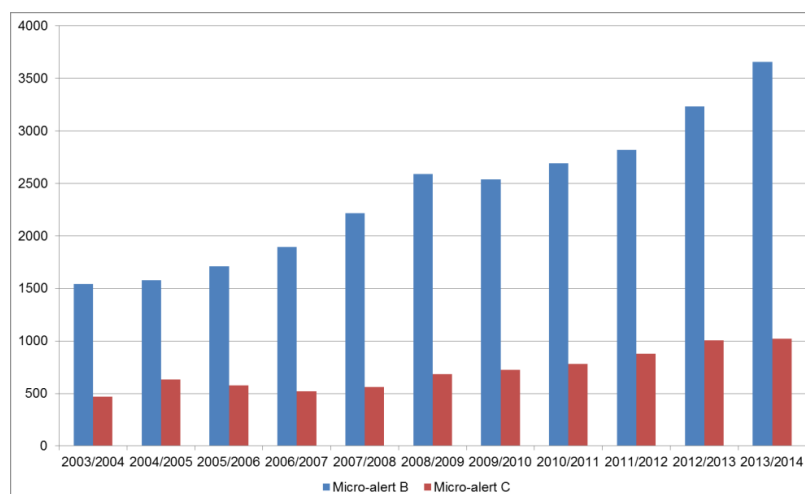


**Figure 22: Annual number of CA-MRSA and HA-MRSA, Western Australia July 2003 to June 2014**

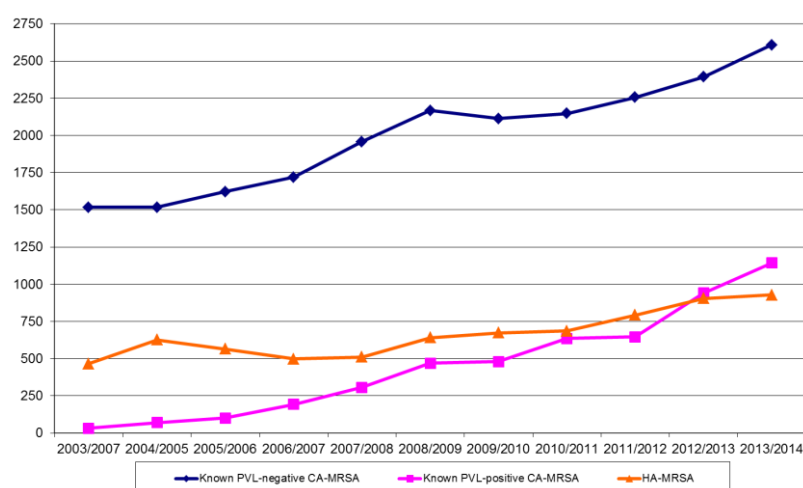


## Perth Metropolitan Health Region

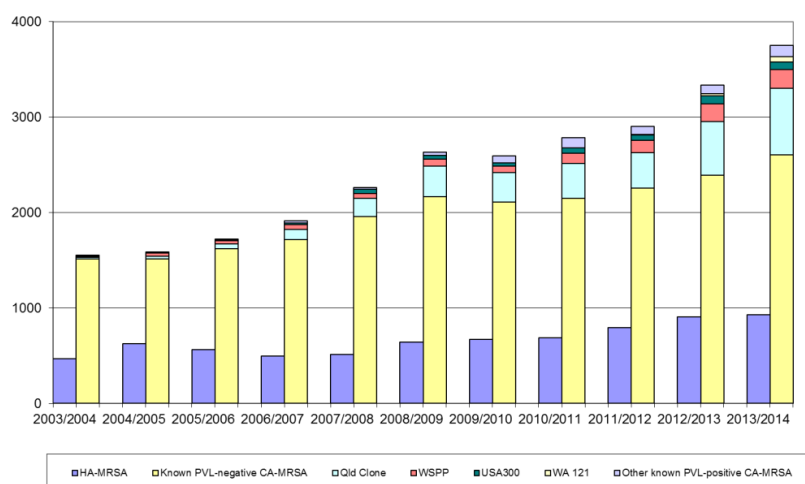
**Figure 23: Annual number of Micro-alert B and Micro-alert C MRSA, Perth Metropolitan Health Region July 2003 to June 2014**



**Figure 24: Annual number of known PVL-positive and -negative CA-MRSA and HA-MRSA, Perth Metropolitan Health Region July 2003 to June 2014**

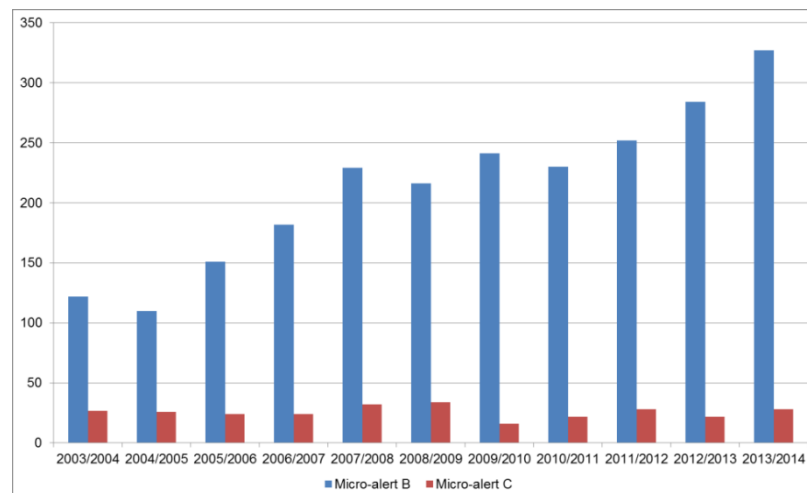


**Figure 25: Annual number of CA-MRSA and HA-MRSA, Perth Metropolitan Health Region July 2003 to June 2014**

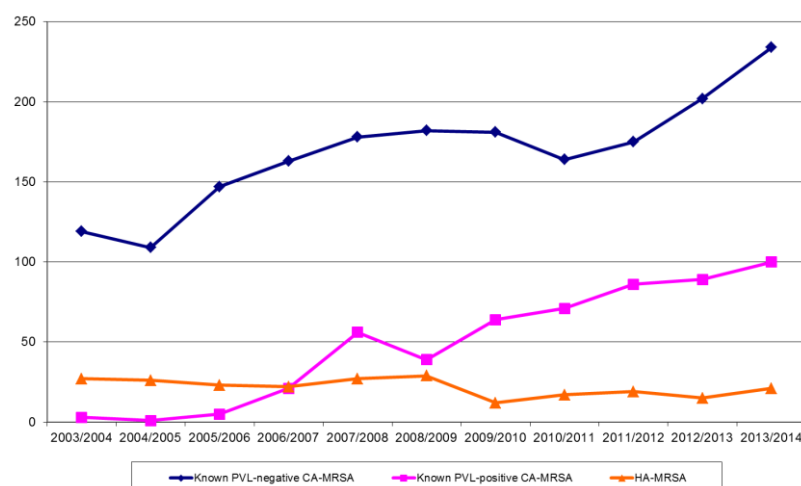


## South West Health Region

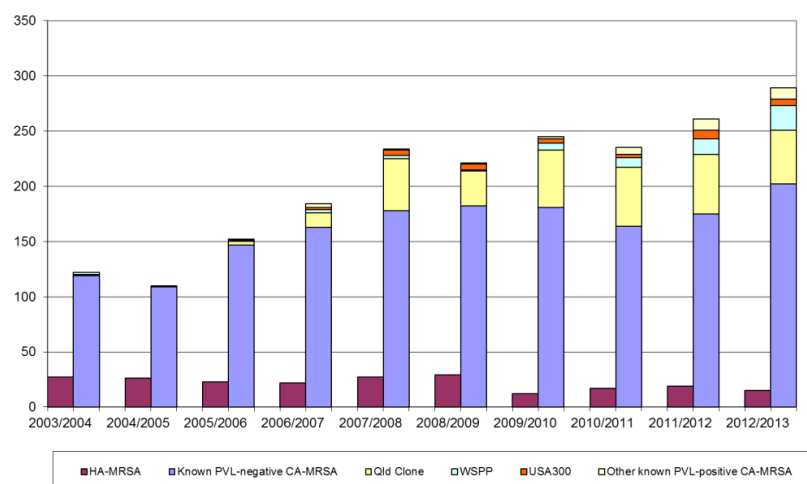
**Figure 26: Annual number of Micro-alert B and Micro-alert C MRSA, South West Health Region July 2003 to June 2014**



**Figure 27: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, South West Health Region July 2003 to June 2014**

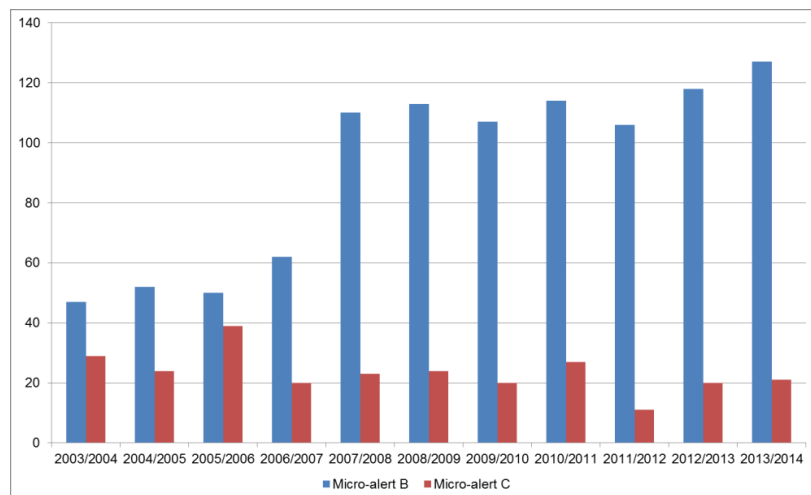


**Figure 28: Annual number of CA-MRSA and HA-MRSA, South West Health Region July 2003 to June 2014**

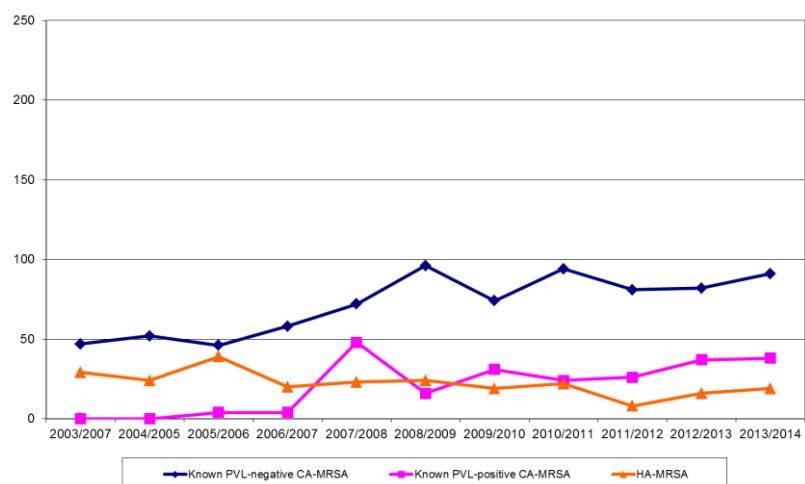


## Great Southern Health Region

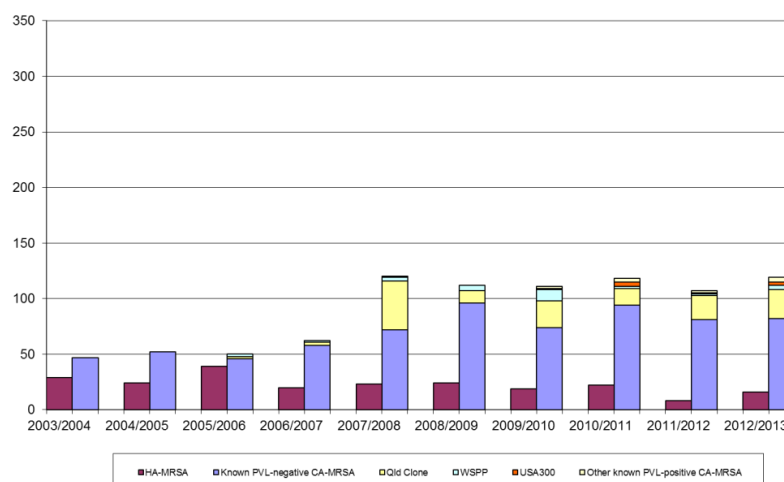
**Figure 29: Annual number of Micro-alert B and Micro-alert C MRSA, Great Southern Health Region July 2003 to June 2014**



**Figure 30: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Great Southern Health Region July 2003 to June 2014**

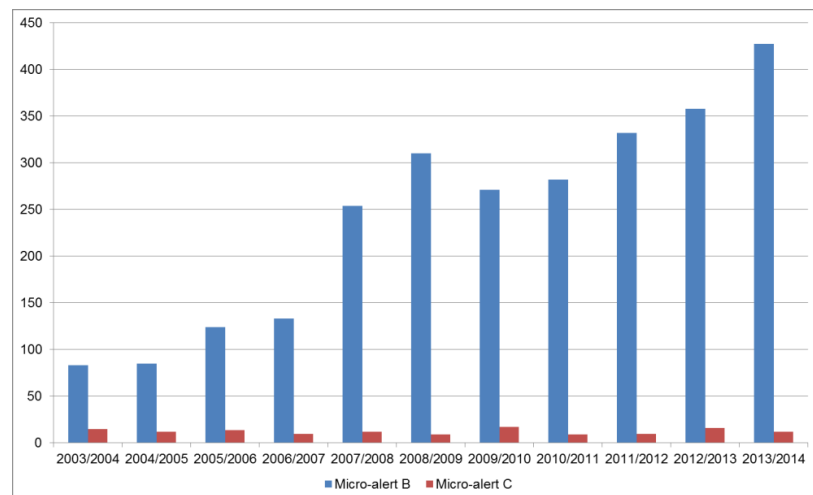


**Figure 31: Annual number of CA-MRSA and HA-MRSA, Great Southern Health Region July 2003 to June 2014**

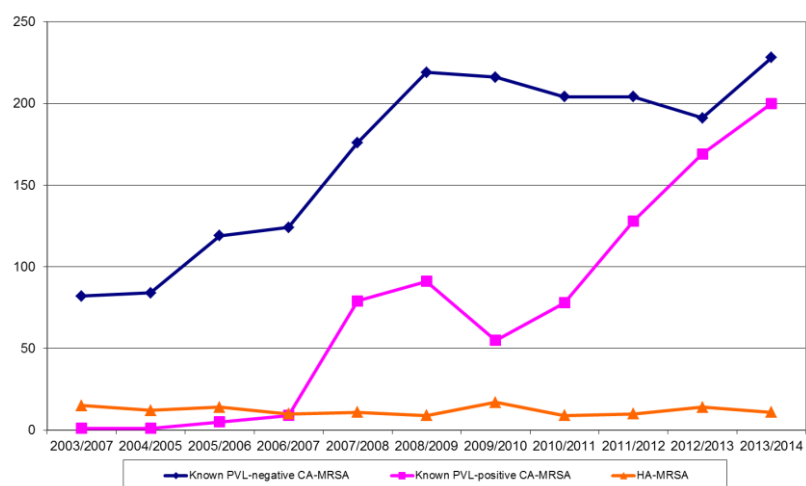


## Midwest Health Region

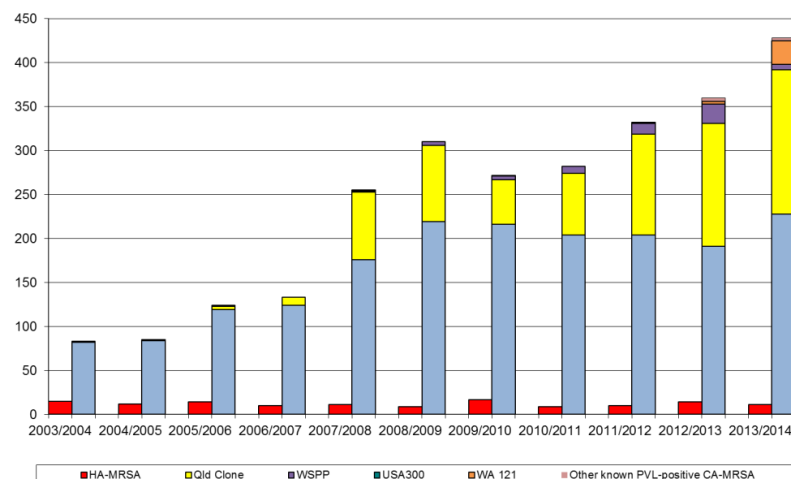
**Figure 32: Annual number of Micro-alert B and Micro-alert C MRSA, Midwest Health Region July 2003 to June 2014**



**Figure 33: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Midwest Health Region July 2003 to June 2014**



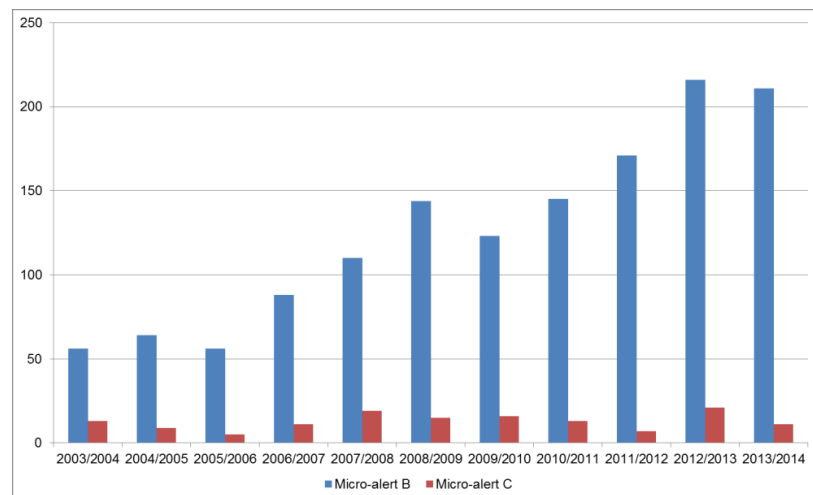
**Figure 34: Annual number of CA-MRSA and HA-MRSA, Midwest Health Region July 2003 to June 2014**



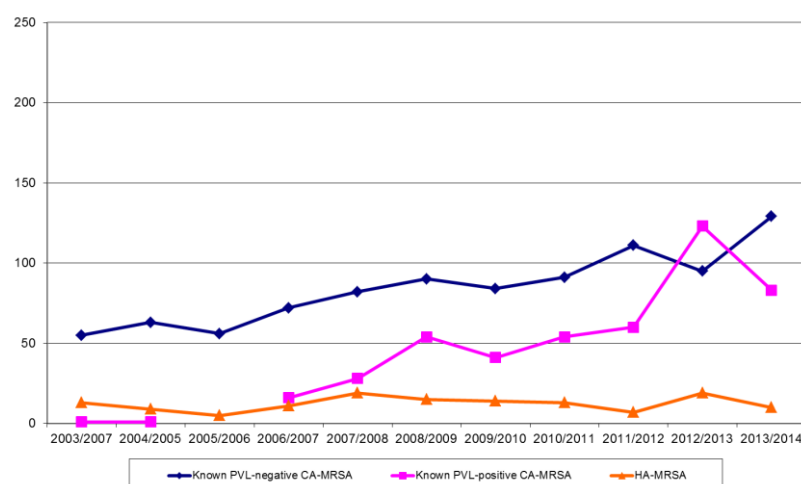


## Central Health Region

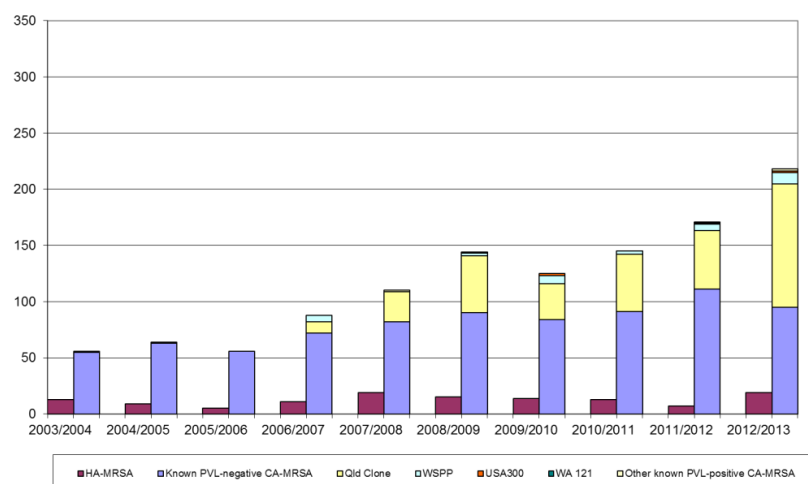
**Figure 35: Annual number of Micro-alert B and Micro-alert C MRSA, Central Health Region July 2003 to June 2014**



**Figure 36: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Central Health Region July 2003 to June 2014**

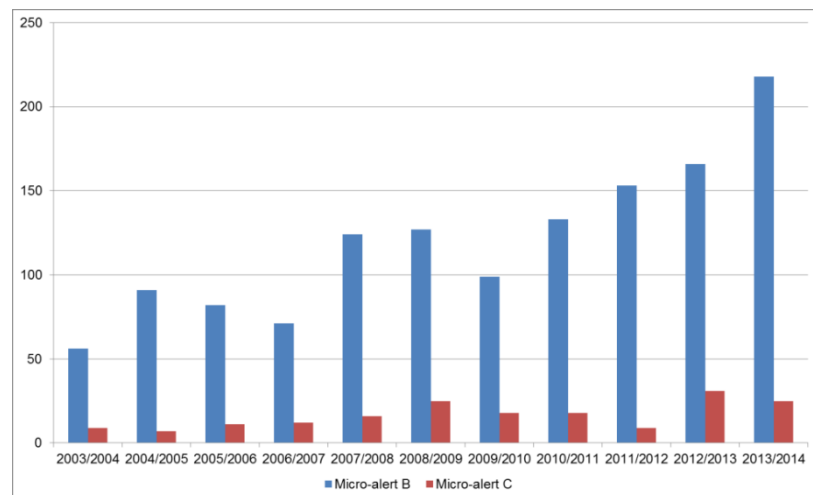


**Figure 37: Annual number of CA-MRSA and HA-MRSA, Central Health Region July 2003 to June 2014**

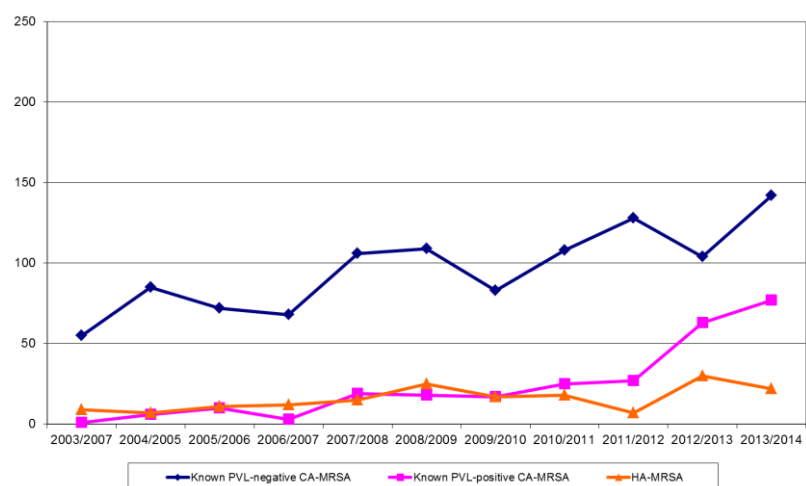


## Goldfields Health Region

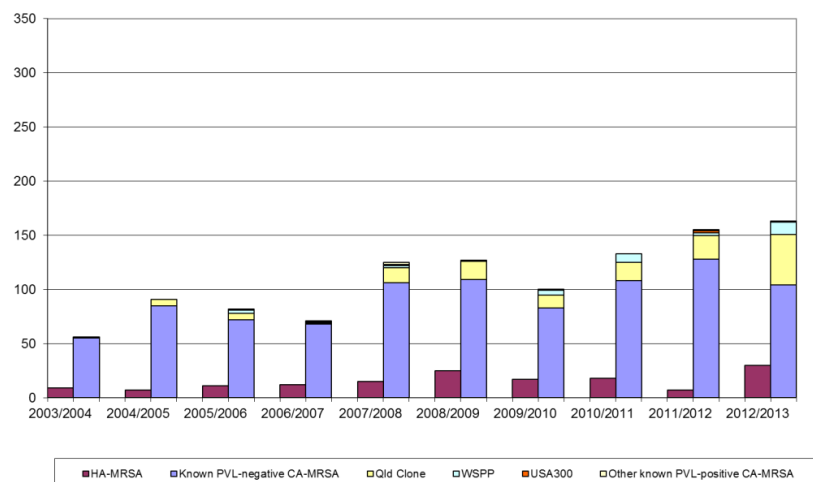
**Figure 38: Annual number of Micro-alert B and Micro-alert C MRSA, Goldfields Health Region July 2003 to June 2014**



**Figure 39: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Goldfields Health Region July 2003 to June 2014**

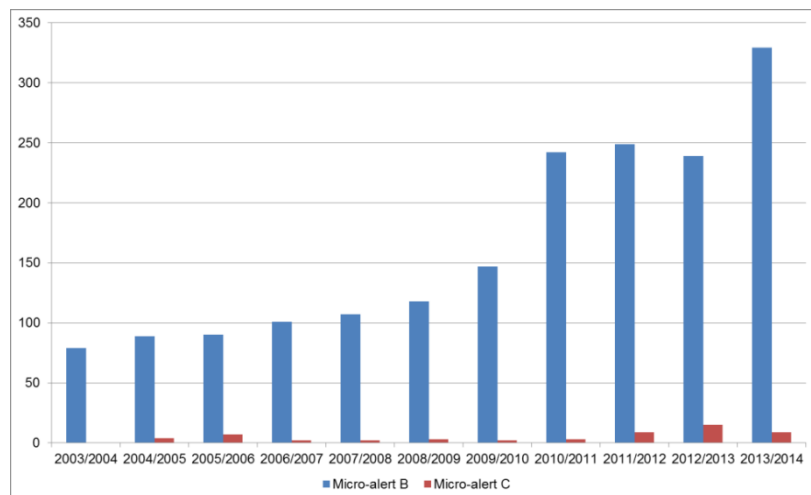


**Figure 40: Annual number of CA-MRSA and HA-MRSA, Goldfields Health Region July 2003 to June 2014**

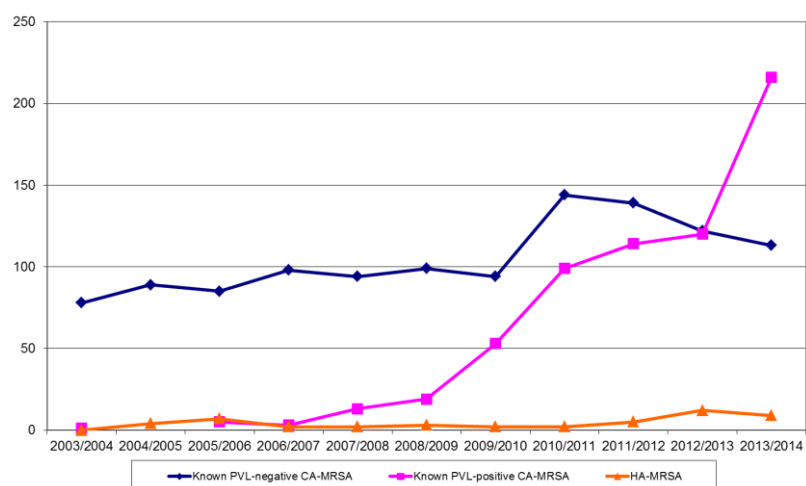


## Pilbara Health Region

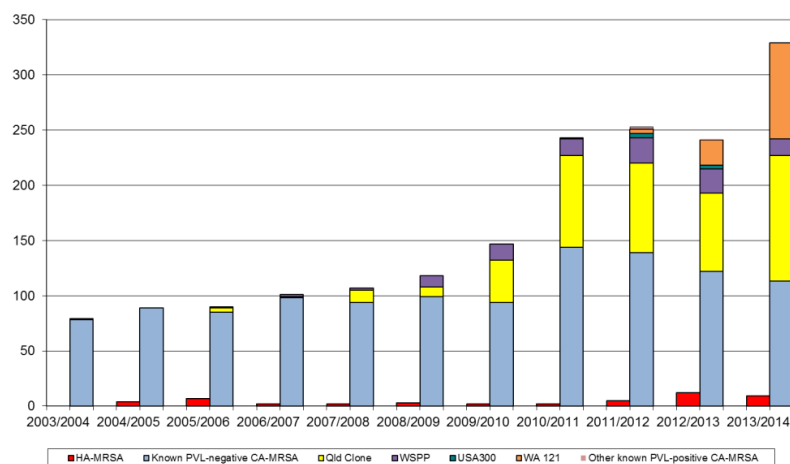
**Figure 41: Annual number of Micro-alert B and Micro-alert C MRSA, Pilbara Health Region July 2003 to June 2014**



**Figure 42: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Pilbara Health Region July 2003 to June 2014**

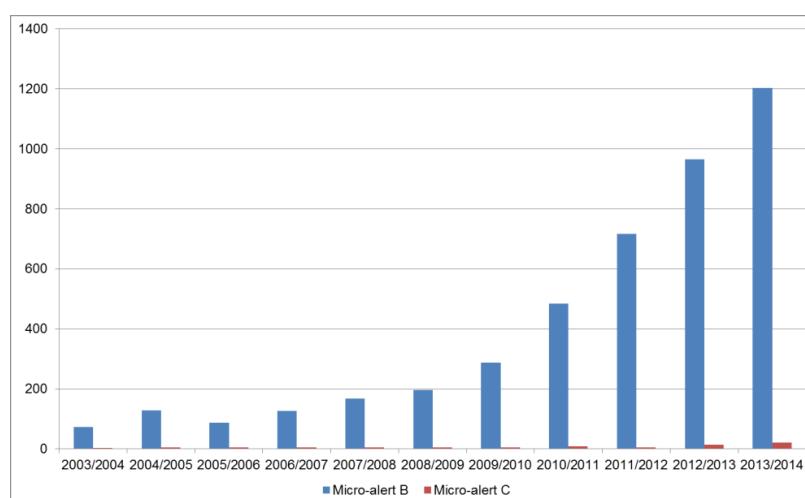


**Figure 43: Annual number of CA-MRSA and HA-MRSA, Pilbara Health Region July 2003 to June 2014**

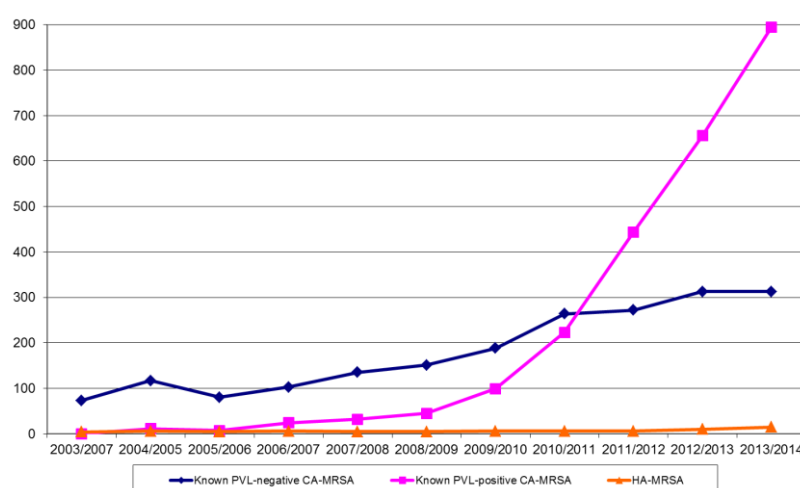


## Kimberley Health Region

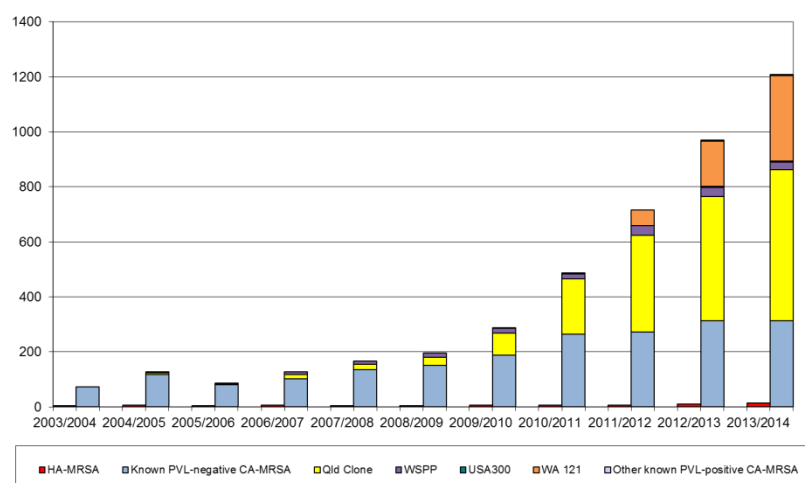
**Figure 44: Annual number of Micro-alert B and Micro-alert C MRSA, Kimberley Health Region July 2003 to June 2014**



**Figure 45: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Kimberley Health Region July 2003 to June 2014**



**Figure 4: Annual number of CA-MRSA and HA-MRSA, Pilbara Health Region July 2003 to June 2014**



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