

**ceptibility to chlorhexidine in  
multidrug resistant clinical  
isolates of *Staphylococcus  
epidermidis* from bloodstream  
infections.**

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# Chlorhexidine baths

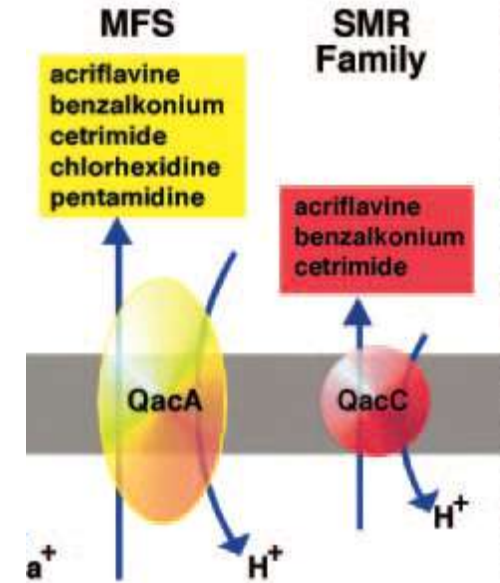
## Effective against all hospital acquired infections

- Universal decolonisation or targeted approach?
- Reduced susceptibility to chlorhexidine?
- Does chlorhexidine select multidrug resistant strains?

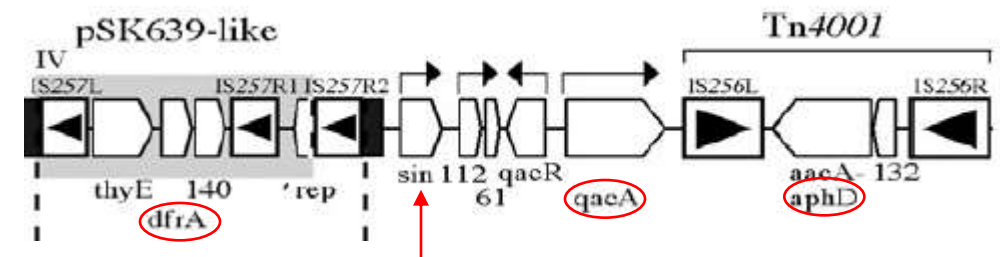


# Qac genes

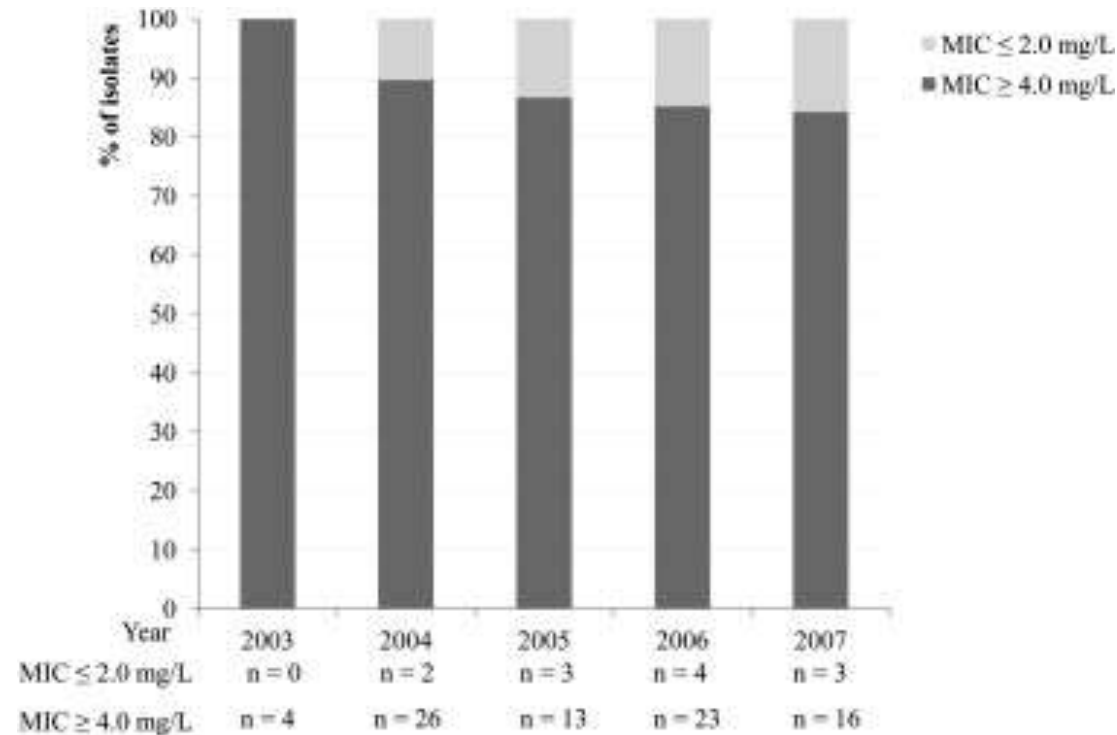
- Encode proton-dependent efflux pumps.
- qacA most strongly associated with reduced susceptibility to chlorhexidine.



- Co-presence on plasmids with antibiotic resistance genes.
- Chlorhexidine selection of antibiotic resistance genes.
- Role of flanking recombinase in transfer



Update to a previous report showing continuing efficacy of chlorhexidine against *MRSA* in ICU over six years.



Sangal *et al*, Int J Antimicrob Agents 2012

- Stable chlorhexidine MICs
- Absence of *qacA/B*

# Setting and isolates

November 2007 to February 2014

ITU of Aberdeen Royal Infirmary

81 Staphylococcus isolates

- 40 MRSA from screening samples
- 41 Staph strains from bloodstream infections



# QacA/B carriage

41 MRSA strains from screening samples

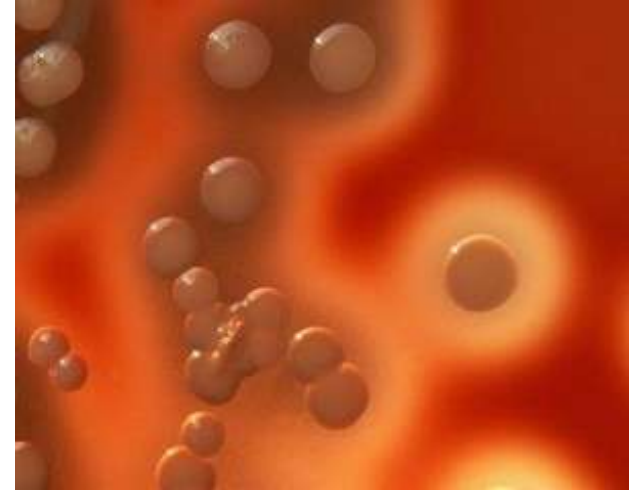
- Minimal qacA/B carriage (absent in 40 strains)

15 *S. aureus* strains from bloodstream infections

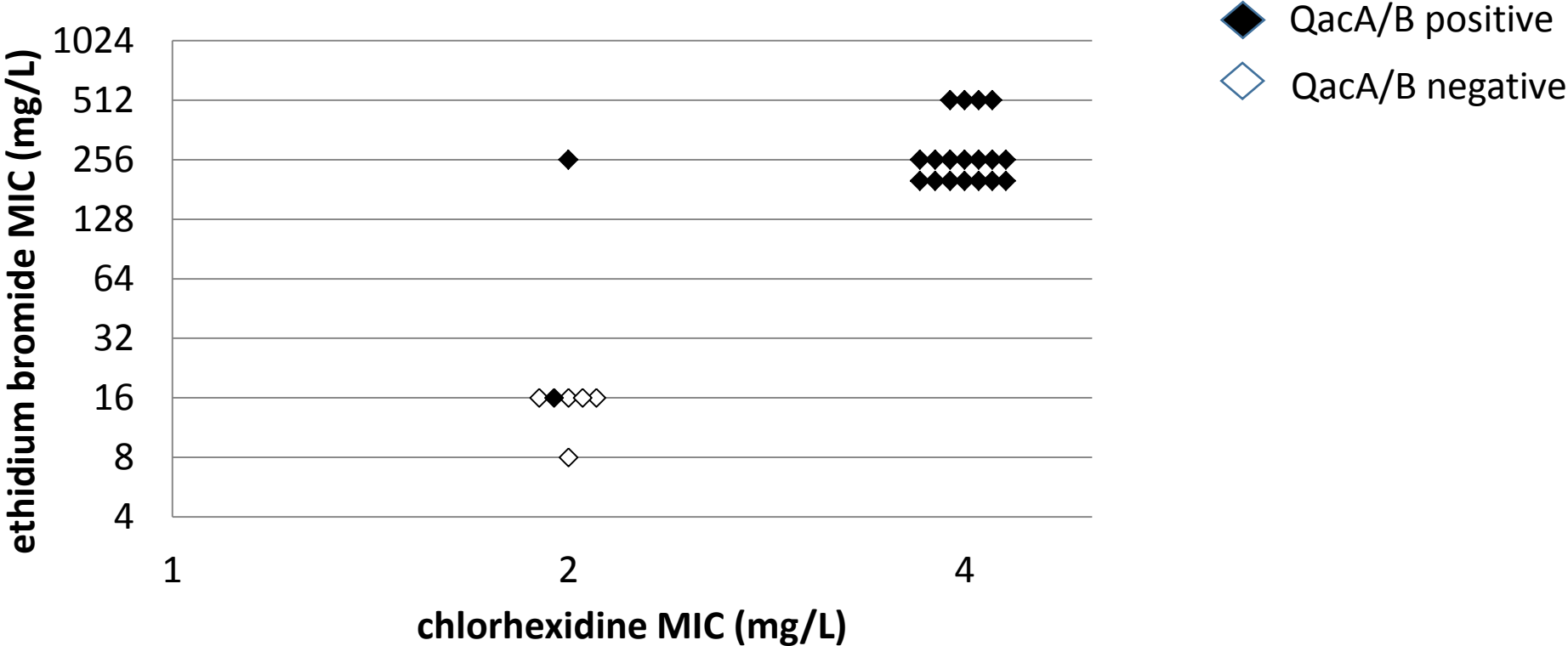
- 12% of total infections over study period
- Minimal qacA/B carriage (absent in 13 strains)

25 *S. epidermidis* strains from bloodstream infections

- 32% of total infections over study period
- **High prevalence of qacA/B carriage (80%)**



# Chlorhexidine MIC of *S. epidermidis* isolates



Most *qacA+*  
*S. epidermidis*  
belonged to  
multidrug resistant  
clone ST-2.

Isolate ID	Date	Sequence type (ST)	Biocide susceptibility genes		
			Chlorhexidine	Mupirocin	Triclosan
STAPH48	Jul-09	ST-559	qacA	ileS (V588F)	sh-fabI
<b>STAPH49</b>	<b>Jul-09</b>	<b>ST-2</b>	<b>qacA</b>	ileS (V588F)	
STAPH51	May-10	ST-83	qacAB*	ileS2	fabI (F204L), sh-fabI
STAPH53	May-10	ST-5	qacAB	ileS2	sh-fabI
STAPH54	Jul-10	ST-5	qacA		
<b>STAPH56</b>	<b>Aug-10</b>	<b>ST-2</b>	<b>qacA</b>	ileS2	sh-fabI
<b>STAPH58</b>	<b>Mar-11</b>	<b>ST-2</b>	<b>qacA</b>		sh-fabI
STAPH59	Apr-11	ST-83	qacAB	ileS2	fabI (F204L)
<b>STAPH60</b>	<b>Aug-11</b>	<b>ST-2</b>	<b>qacA</b>		
<b>STAPH61</b>	<b>Sep-11</b>	<b>ST-2</b>	<b>qacA</b>		
<b>STAPH62</b>	<b>Sep-11</b>	<b>ST-2</b>	<b>qacA</b>		
<b>STAPH63</b>	<b>Sep-11</b>	<b>ST-2</b>	<b>qacA</b>	ileS (V588F)	
<b>STAPH64</b>	<b>Oct-11</b>	<b>ST-2</b>	<b>qacA</b>	ileS (V588F)	
STAPH66	Apr-12	ST-19			
STAPH67	Jul-12	ST-210			sh-fabI
STAPH68	Jul-12	ST-54			
<b>STAPH69</b>	<b>Sep-12</b>	<b>ST-2</b>	<b>qacA</b>	ileS2	
<b>STAPH70</b>	<b>Dec-12</b>	<b>ST-2</b>	<b>qacA</b>		sh-fabI
STAPH73	Jan-13	ST-204			
STAPH74	Jan-13	new			
<b>STAPH75</b>	<b>Jan-13</b>	<b>ST-2</b>	<b>qacA</b>	ileS (V588F)	
STAPH77	Jun-13	ST-59	qacA		sh-fabI
<b>STAPH78</b>	<b>Jul-13</b>	<b>ST-2</b>	<b>qacA</b>		
STAPH79	Sep-13	ST-48	qacA		
<b>STAPH83</b>	<b>Feb-14</b>	<b>ST-2</b>	<b>qacA</b>		

Hijazi K *et al*, 2016, Int J Antimicrob Agents

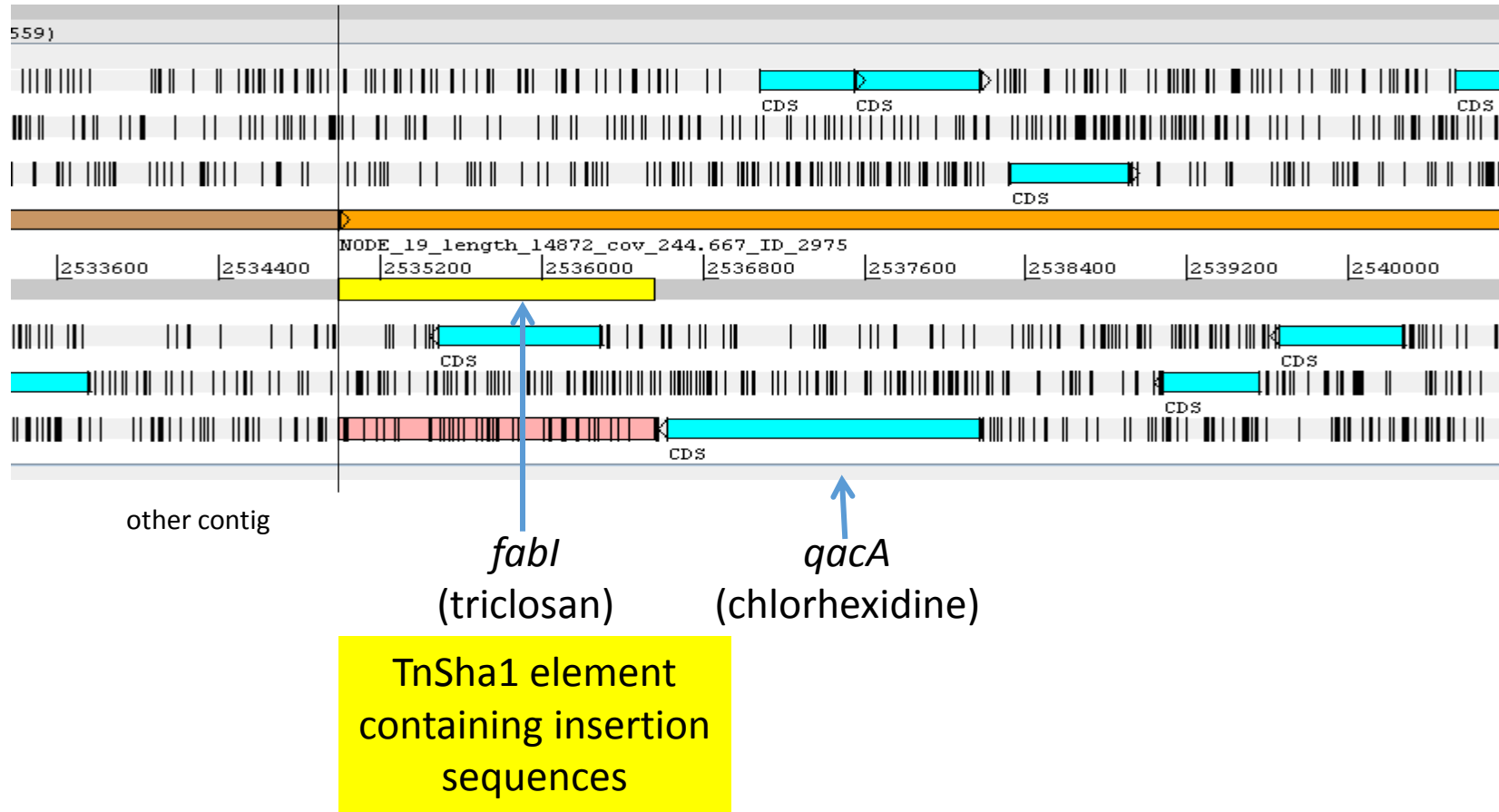


# Antibiotic susceptibility

Isolate ID	species	qacA	antibiotic resistance											
			Flu/oxa	Ceph	Trim	Cipro	Clind	Ery	Fus	Amino	Mup	Rif	Tetr	
STAPH 46	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 47	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 52	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 55	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 57	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 65	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 76	<i>S. aureus</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 66	<i>S. epidermidis</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 67	<i>S. epidermidis</i>	neg	-	+	+	+	+	+	+	-	-	-	-	+
STAPH 73	<i>S. epidermidis</i>	neg	-	-	-	-	-	+	+	+	-	-	-	-
STAPH 74	<i>S. epidermidis</i>	neg	-	-	-	-	-	-	-	-	-	-	-	-
STAPH 43	<i>S. aureus</i>	<b>pos</b>	-	-	-	-	-	+	+	-	-	-	-	-
STAPH 72	<i>S. aureus</i>	<b>pos</b>	-	-	-	-	-	-	-	+	-	-	-	-
STAPH 48	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	-	+	+	+	+	-	-	-	-
STAPH 51	<i>S. epidermidis</i>	<b>pos</b>	+	+	-	+	+	+	+	+	+	+	+	+
STAPH 53	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	-	+	-	+
STAPH 54	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-	-	-
STAPH 56	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	+	-	+
STAPH 58	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-	-	+
STAPH 60	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	-	-	+	+	-	+	+
STAPH 61	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	-	-	+	+	-	+	+
STAPH 62	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-/+	+	+
STAPH 63	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	+	+	+
STAPH 64	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-/+	+	+
STAPH 69	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	-	-	-	+	+	-	+
STAPH 70	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-	-	+
STAPH 75	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-/+	+	+
STAPH 78	<i>S. epidermidis</i>	<b>pos</b>	+	+	+	+	+	+	+	+	+	-	+	+

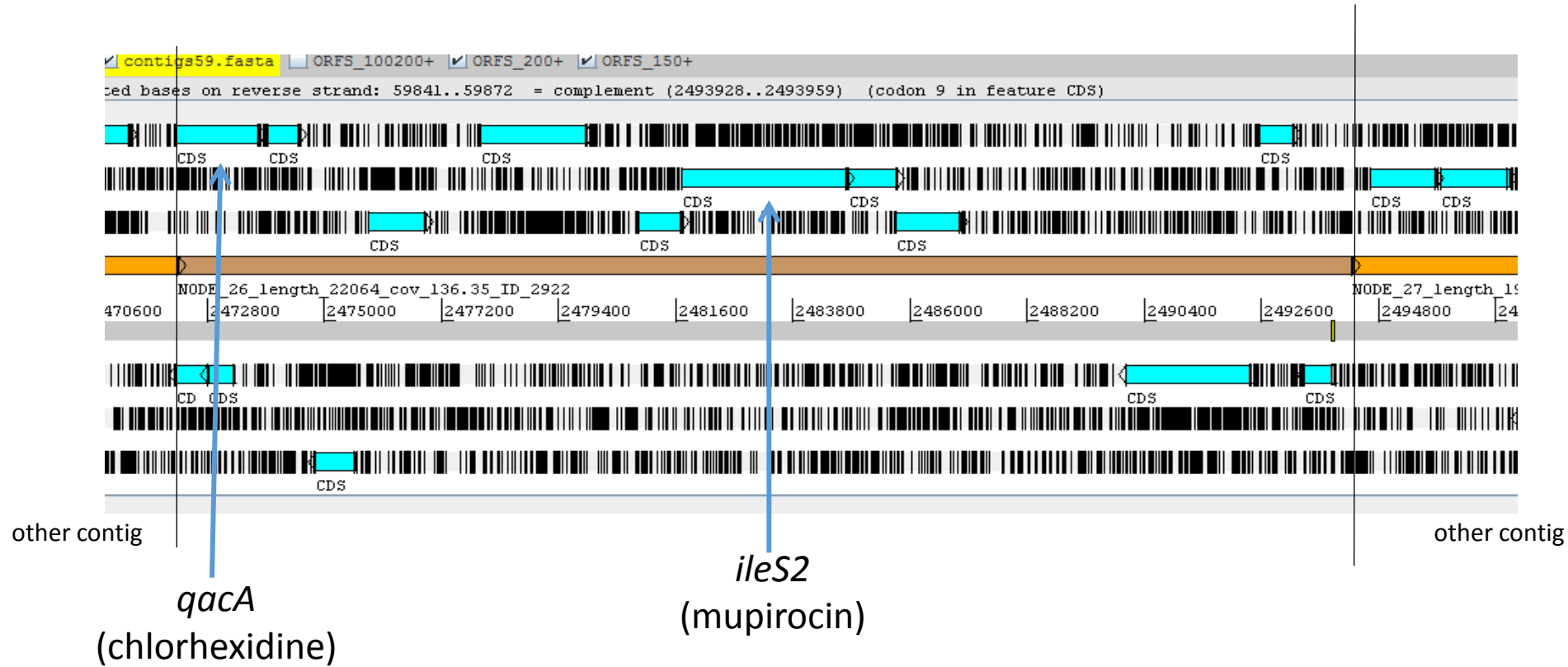
# Co-presence of genes for reduced susceptibility to chlorhexidine and triclosan on mobile elements

STAPH 48



# Co-presence of genes for reduced susceptibility to chlorhexidine and mupirocin on mobile elements

STAPH 51



# Conclusions

- Minimal carriage of *qacA* in *S. aureus* from screening samples and bacteraemias.
- High proportion of *qacA/B* carriage in *S. epidermidis* from bacteraemia patients.
- Co-presence of genes for reduced susceptibility to chlorhexidine, other biocides and antibiotic resistance on the same mobile elements.
  - Insertion sequences and recombinases suggestive of potential horizontal transfer between species.
- Most *qacA+* *S. epidermidis* isolates belonged to multidrug resistant clone ST-2.
  - Potential selection of multidrug resistant *S. epidermidis* by chlorhexidine.

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