## HERD EPIDEMIOLOGY OF MRSA CC398

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# STAPHYLOCOCCUS AUREUS (S. AUREUS) HOST SPECIFICITY

522

133



| TROA Cases | s, Demilark             |              | DANMAP 2013                |  |
|------------|-------------------------|--------------|----------------------------|--|
| spa type   | CC group <sup>(a)</sup> | No. of cases | No. causing infections (%) |  |
| t034       | CC398                   | 527          | 126(24)                    |  |
| t002       | CC5                     | 161          | 90 (56)                    |  |
| t008       | CC8                     | 113          | 72 (64)                    |  |
| t019       | CC30                    | 92           | 67 (73)                    |  |
| t127       | CC1                     | 87           | 43 (49)                    |  |
| t304       | CC8                     | 76           | 26 (34)                    |  |
| t011       | CC398                   | 73           | 19 <mark>(26)</mark>       |  |
| t032       | CC22                    | 49           | 21 (43)                    |  |
| t223       | CC22                    | 48           | 16 (33)                    |  |
| t044       | CC80                    | 47           | 28 (60)                    |  |







### MRSA CC398 THE REAL PROBLEM





### MRSA CC398 THE REAL PROBLEM II

Figure 3.44. Staphylococcus aureus. Trends of invasive isolates resistant to meticillin (MRSA), by country, EU/EEA countries, 2009-2012





Ref: van Cleef et al 2011, Graveland et al 2010, Garcia-Graells et al 2012, Bisdorf et al 2012, Geenen et al 2012, Voss et al 2005, van den Broek et al 2009, Wulf et al 2006



Most studies show the highest increase in prevalence after farrowing (sows) and after weaning (pigs)





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Zoonoses and Public Health <u>Volume 58, Issue 4, pages 238-243, 24 JUN 2010 DOI: 10.1111/j.1863-2378.2010.01340.x</u> http://onlinelibrary.wiley.com/doi/10.1111/j.1863-2378.2010.01340.x/full#f1





#### Most studies show the highest increase in prevalence <u>after farrowing (sows)</u> and <u>after weaning (pigs)</u>



Fig. 1 Percentage of colonized piglets at the four farms taken in the different rearing units at different time points (h: hour, NU: nursing unit, GU: growing unit, GU-1: growing unit 1, GU-2: growing unit 2, FU: finishing unit, FU-1: finishing unit 1 and ...



Verhegghe M et al. Cohort study for the presence of livestock-associated MRSA in piglets: Effect of sow status at farrowing and determination of the piglet colonization age Veterinary Microbiology, Volume 162, Issues 2–4, 2013, 679 – 686. http://dx.doi.org/10.1016/j.vetmic.2012.09.014



#### Why pigs – after weaning?

□ Negative litters start having direct contact with positive litters

Treatments



 $\uparrow\uparrow\uparrow$ 





- - Lincosamides

Penicillin/streptomycin

- --+-- Tetracyclines

11

11 12 13

12 13

- - Penicillins, b-lact. sen. (c)
  - Aminoglycosides
- ---- Pleuromutilins
- --- Penicillins, other
- -- B-- Sulfonam./trimeth.

### MRSA CC398 WHAT IS THE ROLE OF ANTIMICROBIAL USE?



Figure 4.3. Antimicrobial consumption <sup>(4)</sup> in the pig production, and the distribution on age groups, Denmark



Note: The" adjusted total" is adjusted for the increasing export of pigs at 30 kg (see text). "Sows" includes treatment in piglets pre-weaning a) The DAPD is calculated as the number of standard doses for one kg animal divided by the estimated live biomass in the age group at the total population (in tonnes)





### MRSA CC398 HOW DOES IT SPREAD WITHIN A FARM?

#### **OTHER STUDIES - RISK FACTORS ASSOCIATED TO TRANSMISSION WITHIN A FARM**





Ref: EFSA 2008, Graveland et al 2010, Crombé et al 2012, Muller et al 2006, Moodley et al 2011, Broens et al 2012, Broens et al 2011



### MRSA CC398 WHAT ABOUT ZINC



Contents lists available at ScienceDirect

Veterinary Microbiology



Zinc resistance of *Staphylococcus aureus* of animal origin is strongly associated with methicillin resistance

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### <u>MRSA CC398</u> <u>HOW DOES IT ENTER A FARM? -</u> <u>TRANSMISSION BETWEEN FARMS</u>



### Farms with a MRSA-positive supplier have 11 times higher odds to be MRSA-positive







MRSA CC398 in the pig production chain

E.M. Broens<sup>4,5,\*</sup>, E.A.M. Graat<sup>4</sup>, P.J. van der Wolf<sup>4</sup>, A.W. van de Giessen<sup>4</sup>, E. van Duijkeren<sup>4</sup>, J.A. Wagenaar<sup>4,f</sup>, A. van Nes<sup>4</sup>, D.J. Mevius<sup>4,f</sup>, M.C.M. de Jong<sup>4</sup>



### Papers

Transmission of MRSA CC398 strains between pig farms related by trade of animals

C. Espinosa-Gongora, E. M. Broens, A. Moodley, J. P. Nielsen, L. Guardabassi



### <u>MRSA CC398</u> <u>HOW DOES IT ENTER A FARM?</u> -<u>TRANSMISSION BETWEEN FARMS</u>





#### <u>FUTURE</u>

INTERVENTION STUDIES: REDUCE THE PREVALENCE:

- □ Study the effect of <u>reducing the prevalence</u> in farm workers (RISK REDUCTION?)
- □ Identify points of intervention: <u>Hygiene measures</u>
- □ Intoduction of <u>antagonistic bacteria (COMING SOON)</u> ☺
- □ Elimination of <u>TRUE CARRIERS</u> (COMING SOON) ☺









PIGSTAPH

#### PHENOTYPIC STUDY

TRUE PREVALENCE CARRIAGE STATUS NASAL LOAD (SEMI-QUANTITATIVE)

#### **SEROLOGY**

IgG LEVELS

NASAL MICROBIOME

50 CARRIERS AND 50 NON-CARRIERS

16S V3-V5

#### <u>PIG SNPs ANALYSIS</u>

**50 CARRIERS AND 50 NON-CARRIERS** 



Permanent Non-carriers Intermittent

**"TRUE CARRIERS" or "SUPERCARRIERS":** 

High amount of bacteria in the nose Stable carriage (permanently colonized)





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**50 CARRIERS AND 50 NON-CARRIERS** 

#### ENVIRONMENTAL EXPOSURE:

Who has high levels of IgG?

• Pigs with *S. aureus* 

PICSTAPH

• Pigs <u>without</u> *S. aureus* surrounded by positive

pigs / living in high prevalence farms.





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PIGSTAPH

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#### **NASAL MICROBIOME**

50 CARRIERS AND 50 NON-CARRIERS 16S V3-V5

#### **PIG SNPs ANALYSIS**

**NEW** 

50 CARRIERS AND 50 NON-CARRIERS

### CAN WE SELECT NON-CARRIERS IN

**BREEDING PROGRAMS?** 



CANDIDATE GENES



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