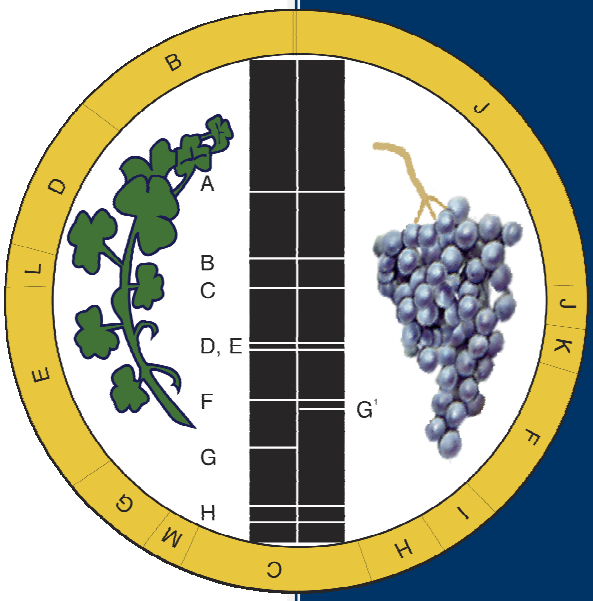
ANNUAL REPORT 2013



National Meticillin-Resistant *Staphylococcus aureus* Reference Laboratory

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Introduction

The primary role of the National meticillin-resistant *Staphylococcus aureus* Reference Laboratory (NMRSARL) is to assist routine microbiology hospitals in the correct identification and control of MRSA using specialized molecular and epidemiological typing techniques.

During 2013 the NMRSARL continued to provide a high quality service to its users and this annual report for 2013 shows in detail all the achievements and the workload of the laboratory throughout the year along with the involvement of laboratory and clinical staff in education and research aspects of MRSA.

The main achievements of the NMRSARL during 2013 were:

- Involvement in the detection of novel strains of MRSA in Ireland. In particular, NMRSARL contributed to the discovery of strains of MRSA carrying novel SCC*mec* elements which have recently emerged in Ireland and Europe (1, 2)[1].
- Continuing to perform surveillance of resistance to glycopeptides (i.e. vancomycin and teicoplanin) and noting continued low levels of resistance which is re-assuring given the importance of these agents in treating serious infection caused by MRSA;
- Continuing to monitor resistance to new antibiotics and noting continued lack of resistance. There is a need for continued vigilance to detect emergent resistance;
- Involvement in the recognition of the introduction of new strains of community associated MRSA causing hospital outbreaks and assisted in controlling the outbreak;
- Expansion of service repertoire and the introduction of multiplex real time PCR techniques for the detection of resistance and virulence mechanisms;
- Cost reduction in line with maintaining a quality services;
- The continued strengthening of academic links between the NMRSARL and Trinity College Dublin.

Clinical Director

Grainne Brennan

Chief Medical Scientist

[1] All references are listed in the bibliography at the back of this report

Role of the Laboratory

Since its establishment in 2002, the Laboratory has supported efforts to prevent and control MRSA in Ireland by providing expertise to laboratories in the correct identification of *Staphylococcus aureus* isolates, by tracking circulating strains as part of infection control, by detecting the emergence of new mechanisms of resistance to antibiotics, by screening for the presence of novel virulence factors or toxins, and by participation in research and development initiatives at home and abroad.

Services

The NMRSARL provides the following services:

Investigation of MRSA isolates using phenotypic and molecular techniques for the following reasons:

- confirmation of *S. aureus* identity
- epidemiological typing
- investigation of resistance
- detection of the *pvl* gene encoding the Panton-Valentine leucocidin toxin and exfoliative toxins *etA, etB* and *etD*
- characterization of selected isolates by staphylococcal protein A (*spa*) typing

Investigation of meticillin susceptible *S. aureus* (MSSA) isolates

- For the detection of the *pvl* and exfoliative toxin genes
- Outbreak investigation of strains using *spa* typing

Advice

- on treatment and management of patients with MRSA through its medical director
- on infection control through the infection control team of SJH
- on laboratory aspects of MRSA through the scientific staff of NMRSARL..

Isolates

Isolates, recovered from patients attending community medical practitioners or hospitals, are submitted to the laboratory from all hospital microbiology laboratories throughout the Republic of Ireland.

In addition to this the NMRSARL also provides laboratory support for the MRSA component of EARS-Net in Ireland. All Irish hospital laboratories participating in EARS-Net send MRSA isolates from blood cultures (one per patient per quarter) to NMRSARL where they are investigated for resistance to oxacillin, vancomycin and teicoplanin using standard E-test or E-test™ macro-method techniques. NMRSARL also provides data on rates of resistance to other clinically useful antibiotics.

Administration

The laboratory is located in St. James's Hospital and is administered within the Laboratory Medicine (LabMed) Directorate.

Routine Laboratory Work

Reference Laboratory Work

In NMRSARL, all requests received are considered incidents and may include requests for information, requests to investigate isolates from potential outbreaks or requests to investigate some other problem with the isolate(s). Figure 1 summarises the number of incidents investigated during 2013 along with the number of tests performed on isolates received within the laboratory.

Briefly, the declining rates of MRSA in Irish hospitals continued in 2013 resulting in a decrease in the number of isolates investigated under the EARS-Net project. In contrast however, the reference laboratory workload increased particularly with regards to more specialised techniques including *spa* typing and molecular detection tests.

The amount of information obtained from *spa* typing of isolates is invaluable in assisting in the monitoring of strains throughout Ireland and the early detection of emerging strains.

During the year the NMRSARL also assisted several users investigating issues arising with coagulase negative Staphylococci and while the NMRSARL's knowledge is limited with regards to CNS, some techniques used when investigating MRSA may also be applied to other Staphylococcal species.

European Antimicrobial Resistance Surveillance Network (EARS-Net)

Twenty-six laboratories throughout Ireland submitted 225 MRSA isolates causing blood-stream infections to NMRSARL during 2013 for monitoring of epidemiological types and resistance to clinically significant antimicrobials. Clinical data on these isolates is submitted to the Health Protection Surveillance Centre (HPSC) under the EARS-Net project, a European initiative that, in Ireland and this data generated from the laboratory work in the NMRSARL provides HPSC with information on rates of resistance to clinically useful antibiotics.

All isolates undergo Antibiogram-Resistogram (AR) typing performed in accordance with EUCAST methodology using a panel of 23 antimicrobial agents. Where interpretive criteria are not available from EUCAST, criteria set by the Clinical and Laboratory Standards Institute (CLSI) or developed in the NMRSARL is used. The oxacillin minimum inhibitory concentration (MIC) is determined and isolates are screened for reduced susceptibility to vancomycin and teicoplanin using the E-test™ macro-method along with screening agar plates containing vancomycin and teicoplanin.

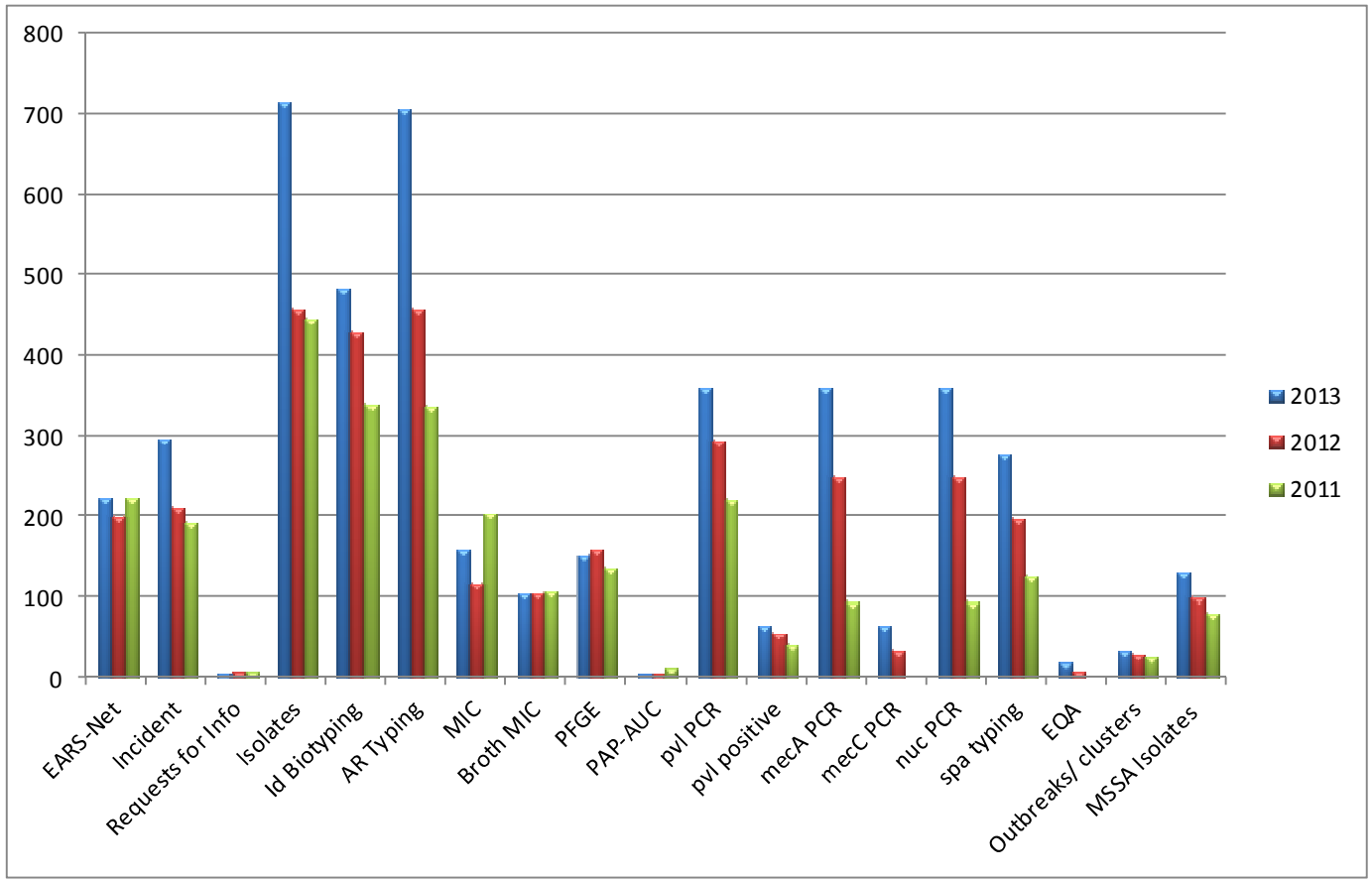


Figure 1: Routine workload of the National MRSA Reference Laboratory in 2013 compared with that of the previous years. *pvl*, Panton-Valentine leukocidin toxin gene; *mecA*, gene encoding meticillin resistance; *mecC,* gene encoding meticillin resistance *spa*, staphylococcal protein A gene typing; PFGE, pulsed field gel electrophoresis. Id Biotyping, MIC, AR Typing and PFGE is on performed all EARS-Net isolates.

Monitoring resistance among Irish strains of MRSA

The phenotypic epidemiological typing techniques used in the NMRSARL enables the laboratory to monitor resistance among MRSA strains against clinically useful antimicrobial agents and to identify emerging resistance that may cause concern into the future with the EARS-Net isolates providing a representative collection of isolates recovered throughout the country. While the most prevalent MRSA strain circulating in Irish hospitals exhibits a non-multiantibiotic resistant susceptibility profile, emerging community associated strains carry multiple virulence and resistance genes is a concern and enhanced surveillance of these strains is essential in order to ensure that these strains do not spread into Irish hospitals.

Fusidic Acid Resistance

Monitoring antimicrobial resistance in MRSA isolates investigated under the EARS-Net project has shown that resistance to fusidic acid increased from <10% between 1999 and 2001 to 27% in 2006. This increase continued through to 2010 and, while a 7% reduction was seen in 2011, the increasing trend returned and remained similar to 2012 at 39% (88/225) of all EARS-Net isolates exhibiting resistance.

This increasing trend over 12 years is a worrying development as fusidic acid remains a clinically useful antimicrobial for difficult to treat skin and soft tissue infections. There are several reported genes associated with fusidic acid resistance in *S. aureus* and the NMRSARL is collaborating with colleagues in the Dublin Dental University Hospital (DDUH) to further investigate the mechanism of resistance and possible causes for the increase observed in recent years.

Glycopeptide Resistance

Vancomycin and teicoplanin remain the mainstay for the treatment of serious infection caused by MRSA and there has been increasing concern about the development of resistance to these agents in recent years .

All isolates are screened for reduced susceptibility to glycopeptides using agar screening methods. EARS-Net MRSA isolates are also investigated by a commercial MIC system using a macro-method which screens for hetero-glycopeptide resistant *S. aureus* (hGISA). Isolates yielding positive results in the E-test macro-method are confirmed as hGISA by population analysis profile-area under the curve (PAP-AUC) ratio determination.

During 2013, no EARS-Net isolates exhibited reduced susceptibility to glycopeptides. Six reference laboratory isolates were further investigated by PAP-AUC and two were confirmed as hGISA.

Mupirocin Resistance

Mupirocin is the agent of choice to eradicate nasal colonisation with MRSA. The detection of resistance among MRSA strains circulating in Irish is of importance as increasing prevalence will undoubtedly have a major impact on the success of decolonisation, a major strategy in preventing the spread of MRSA.

High-level mupirocin resistance (Hi-MupR) is a common feature among older strains of MRSA in Irish hospitals. More recently resistance has been observed in an unfamiliar AR pattern exhibiting mupirocin resistance along with resistance to the aminoglycosides gentamicin, kanamycin and tobramycin and which molecular typing has shown is associated with ST22.

During 2013, mupirocin resistant was recognized among seven percent of EARS-Net isolates with 40% of these isolates found to be ST22.

Collaborative work involving NMRSARL and the DDUH includes investigating the Hi-MupR – conferring plasmids in these isolates.

Linezolid, Quinupristin/ Dalfopristin, Ceftaroline, Daptomycin and Tigecycline

Monitoring of these newer agents for treatment of MRSA infection is important, as resistance detection is rarely carried out and difficult with not all diagnostic laboratories having the capability to perform appropriate tests.

During 2013, 100 MRSA isolates (from the EARS-Net study) were tested for susceptibility to quinopristin/dalfopristin, daptomycin and tigecycline by E-test MIC determination along with quinopristin/dalfopristin, ceftaroline and tigecycline by disk diffusion. All isolates were susceptible.

All isolates submitted to the laboratory were also tested against linezolid. During the year while no MRSA isolates were fond to be resistant, the NMRSARL assisted users in the investigation of linezolid resistance in a *Staphylococcus epidermidis* which has been associated with an outbreak in their hospital.

In general resistance to linezolid among *Staphylococci* is unusual and we are working with our research colleagues in investigating the the plasmids carrying *cfr* and other mechanisms of resistance (3).

Monitoring the Epidemic Strains Prevalent in the Irish MRSA Population

Through the epidemiological data obtained from isolates submitted to the EARS-Net project, NMRSARL monitors MRSA strains that are circulating in Irish hospitals.

Previously we have shown that the majority of MRSA isolates recovered in Irish hospitals between 1971 and 2003 belonged to one of seven internationally spread MRSA clones (ST239, ST247, ST250, ST5, ST22, ST36 and ST8) and had SCC*mec* types I, Ia, II, III or IV but ST8 isolates showed an unexpected degree of diversity within the SCC*mec* element. Since 2004, NMRSARL has combined AR typing results with PFGE typing results to generate AR-PFG types (4). Figure 3 shows how the AR-PFG type distribution in participating hospitals has changed since 2004 and also includes data on multilocus sequence typing (MLST) and staphylococcal cassette chromosome (SCC) *mec* typing extrapolated from a study completed in 2004 (5).

Among MRSA isolates recovered from blood, the prevalence of one AR-PFG type 06-01 increased from 22% in 1999 to 81.2%% in 2010 but reduced to 74.6% in 2011. In 2013 this strain was once again associated with 85% of isolates submitted for investigation to the NMRSARL.

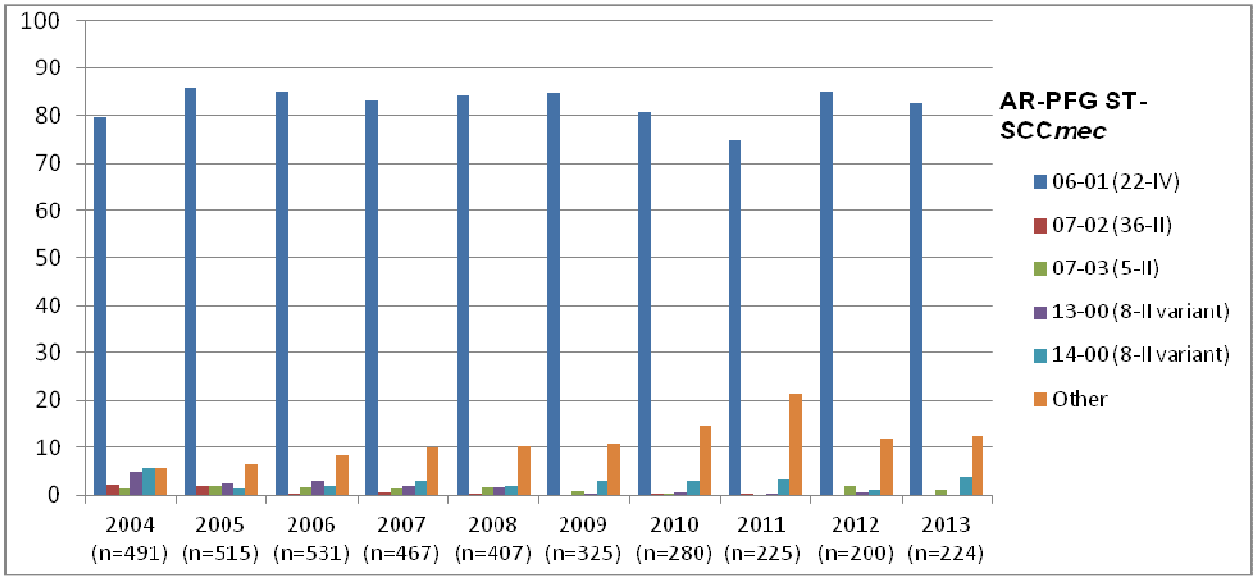


Figure **3: Epidemiological type distribution (%) among MRSA isolates in Irish hospitals that participate in the European Antimicrobial Resistance Surveillance Network (2004 to 2013).**

AR-PFG, antibiogram-resistogram type and pulsed field gel electrophoresis group; ST-SCC*mec*, MLST sequence type and SCC*mec* type (SCC*mec* II variant, variants of SCC*mec* type II).

Molecular Epidemiological Typing: *spa* Typing

In recent years the NMRSARL has increased the number of isolates investigated using *spa* typing in order to allow easier comparison of Irish epidemiological typing data with that from other countries.

DNA sequencing of the Staphylococcal protein A (*spa*) gene is a well-established discriminatory method for outbreak investigations and has also been shown to be suitable for long-term epidemiological studies (5).

spa typing recognises mutations or repeat insertion/deletion events that can cause changes in the polymorphic X region of the *spa* gene. The availability of MLST data associated with *spa* types on an online database facilitates comparison of Irish isolates with isolates from all other countries.

Of all isolates submitted to the NMRSARL during 2013, 279 were investigated by *spa* typing. This analysis included a selection of EARS-net isolates, all PVL-positive isolates and some PVL-negative isolates that exhibited an AR pattern similar to that of a non-multi-antibiotic resistant pattern, described as AR06. These isolates are not assigned to an AR type as they are urease positive but instead are termed as 'No Type' ('NT') because experience in NMRSARL with such isolates has shown that these isolates cannot be reliably typed by AR typing and required additional investigation (6).

Based Upon Repeating Patterns (BURP) analysis clusters *spa* types based on the repeat succession pattern of *spa* types and has shown to have good concordance with MLST data. BURP analysis of all isolates investigated during 2013 is shown in Figure 1.

There were 27 different *spa* types recognised among 65 PVL-positive isolates, eighteen of which was seen in only one isolate. Among the remaining isolates there were some predominant *spa* types with *spa* types t008 (ST8), t019 (ST30) and t852 (ST22) accounting for 26% (17/65), 15% (10/65) and 8% (5/65) respectively.

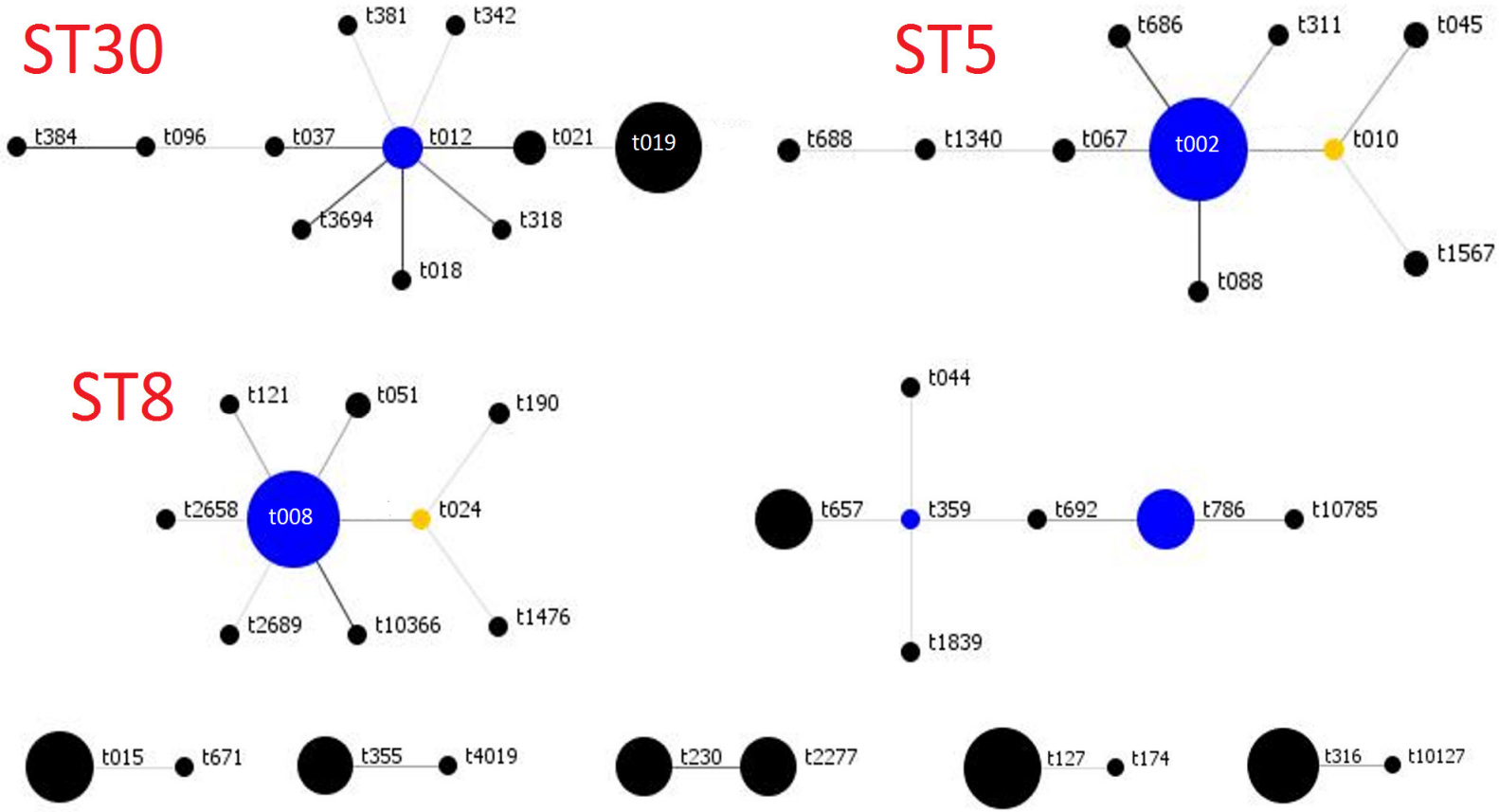
spa type t008 (also known as USA 300) has been recognised among Irish PVL positive isolates since 2007 with the highest number of isolates of this spa type recovered in 2009 (29%, 11/38 isolates). While this strain has been associated with a number of nosocomial outbreaks in the United States, to the best of our knowledge, no such incidents have occurred in Ireland.

spa type t852 is associated with ST22 and, while the PVL-negative ST22-MRSA-IV is the pandemic strain in Irish hospitals, this PVL positive strain is widely associated with India and, along with ST772-MRSA-V, has displaced previously predominant nosocomial strains in Indian hospitals.

The PVL-negative isolates (n=143) exhibited much greater diversity. Among these isolates investigated there were 58 different *spa* types with 36 of these recognised in only one isolate.

The most frequently occurring *spa* type among PVL negative isolates was t002, associated with ST5 (15%, 20/137).

spa type t878 associated with ST779, which has been reported to carry a novel pseudo SCC*mec*-SCC-SCCCRISPR element continued to be detected in Irish hospitals and was recognised in three isolates (2).



Singletons (representing 14% of all isolates): t034, t040, t078, t085, t091, t148, t209, t408, t437, t563, t878, t937, t2526, t2622, t4545, t5228, t11845, t12025, t12117, t12930, t13258

Excluded spa-types: 8% of all isolates

Figure 2: Population snapshot based on BURP analysis of all *S. aureus* isolates that were *spa* typed during 2013. BURP parameters excluded *spa* types with less than five repeats and clustered *spa* types into *spa* clonal complexes (*spa*-CC) if the cost distance was less than four. Analysis resulted in 10 *spa* CCs, 21 singletons, and 9 excluded *spa* types. Each dot represents a unique *spa* type. The diameter of a dot is proportional to the number of isolates of the corresponding *spa* type. Blue dots represent group founders, defined as the *spa* type(s) with the highest founder score within a CC while yellow dots show a co-founder. Note that the spacing between linked *spa* types and between unlinked *spa* types and *spa* CCs provides no information concerning the genetic distance between them. *spa* inferred MLST types are shown in red.

Panton-Valentine Leukocidin (PVL) Carriage in MRSA in Ireland

During 2013 staff in the NMRSARL and collaborators in the Dublin Dental University Hospital published work characterizing all PVL positive *S. aureus* isolates submitted to the laboratory between 2002 and 2011 (7). DNA microarray analysis was used to detect 334 *S. aureus* genes including antimicrobial resistance and virulence genes and capsule types while also assigning isolates to a multilocus sequence type clonal complex and sequence type.

In total 229 isolates were included in the study and it was found that the epidemiology of pvl-positive *S. aureus* is changing. There were 16 different genotypes recognized among 190 MRSA isolates and five genotypes among 39 MSSA isolates. Predominant genotypes included CC/ST8-MRSA-IV, CC/ST30-MRSA-IV, CC/ST80-MRSA-IV, CC1/ST772-MRSA-V, CC30-MSSA, CC22-MSSA, and CC121-MSSA. Using epidemiological data it was found that some strains had been imported into Ireland on several different occasions and that 70% of isolates for which patient data was available were from the community including six family clusters of pvl-positive MRSA.

In 2013, 333 *S. aureus* isolates were tested for carriage of the *lukS-PV* and *lukF-PV* genes encoding for PVL. These isolates were selected based on clinical presentation or phenotypic epidemiological typing data and included 35 EARS-Net MRSA isolates, 108 meticillin-susceptible *S. aureus* and 192 MRSA isolates.

Eight percent of MSSA (9/108) and 27% of MRSA (52/192) were PVL-positive. An additional nine percent (3/33) of MRSA causing blood stream infections were also found to be PVL positive.

A review of clinical information submitted with these isolates showed that while skin and soft tissue infection was the predominant clinical presentation, on a number of occasions travel was also a common feature with patients having recently travelled to, among others, Paraguay, Egypt, North and S. America and the Phillipines.

MRSA Associated with Animals

Due to the close relationship between animals and their owners, animal contact continues to be a possible source of MRSA in humans. Strains recovered from companion pets, including cats, dogs and horses are those most frequently seen in our hospitals while MRSA recovered from livestock are distinctly different.

ST398-MRSA was first reported in the Netherlands where it was recovered from pigs and pig farmers and has since been associated with cattle, sheep and chickens in numerous European countries as well as in the USA and Canada (8). Since the NMRSARL reported on the first case of this strain recovered in an Irish patient in 2012, the laboratory has continued to monitor for it and recognized an additional isolate among isolates submitted to the laboratory in 2013.

In the first case the patient had no contact with animals and the isolate was recovered during pre -admission screening, on this occasion the patient had close contact with pigs and presented with recurrent skin abscesses.

Isolates of ST398 lineage often carry multiple resistance genes including those encoding resistance to aminoglycosides, tetracycline and trimethoprim they lack other virulence genes.

In addition to the human cases mentioned above the NMRSARL has also been working with colleagues in the veterinary laboratory in characterizing ST398 isolates recovered from pigs in Ireland.

The report of the discovery of *mecC*, the gene encoding low-level resistance is of great concern and, while originally reported in strains from Ireland, England, Scotland and Denmark it has now been widely reported throughout Europe and is mainly associated with animals (1).

The NMRSARL have alerted hospital microbiology staff of the difficulties in detecting this strain of MRSA due to the low level oxacillin resistance it exhibits. The availability of molecular tests in the NMRSARL for the detection of *mecC* continues to assist any users who have encountered difficulties in distinguishing between *mecA* and *mecC* encoding MRSA and MSSA.

Quality Management System

During 2013, the NMRSARL was fully accredited under Clinical Pathology Accreditation (CPA) standards incorporating ISO 15189 and applied for inspection from the Irish National Accreditation Board (INAB) in early 2014. The quality management system in place within NMRSARL ensures that there are coordinated activities in place in order to continually improve the effectiveness and efficiency of the laboratory. These include internal and external audits, document reviews, key performance indicators (quality indicators) and regular communication with users of the laboratory.

Quality Indicators

Turn-around Times

Verbal reports are issued on urgently requested tests as soon as the results are available. For other isolates received, a printed report is issued with additional tests results reported on subsequent reports.

During 2013, 98% of isolates were reported within the stated turnaround time and where reports exceeded the TAT there were issues relating to mixed culture delayed the report.

Internal Audits

A schedule of audits were completed during 2013 ensuring the quality of pre-examination, examination and post examination processes was maintained. From these audits there were no serious non-conformances identified and any issues raised have been completed.

User survey

A survey of users was completed and comments provided will be used in the future development of the laboratory. We would like to thank all users who took the time to complete the survey.

Service Developments

During 2013, *spa* typing was used more frequently in outbreak situations with the aim to replacing PFGE with this sequence-based technique allowing greater comparison of isolates typed in the NMRSARL with those reported from other countries.

Validation of a real-time PCR for the detection of exfoliative toxins *etA*, *etB* and *etD* was completed and this service is now available for users.

Resources

Staff

The staffing complement of the NMRSARL consisted of a Chief Medical Scientist (Ms. Gráinne Brennan), a Molecular Microbiologist Dr. Pamela Morgan), a Basic Grade Medical Scientist (Ms. Emma Gibbons) and a Medical Laboratory Aide (Mr. Paul Grier). During 2013 the Molecular Microbiologist and the Basic Grade Medical Scientist were on extended leave of absences and in their absence Medical Scientists (Ms. Tanya Fleming and Ms. Sinead Saab) were seconded from the routine microbiology department.

Dr. Anna Shore continued in her role as a Lecturer in Applied and Translational Microbiology and, in this role continued her involvement in the development of applied research in MRSA between the School of Dental Science and NMRSARL.

The role of Director was discharged in an honorary capacity by Dr. Brian O'Connell, Consultant Microbiologist, SJH. Professor Hilary Humphreys of the Royal College of Surgeons in Ireland and Beaumont Hospital continued in his role of Honorary Consultant to provide an external perspective to the activities and services provided by NMRSARL.

Facilities

NMRSARL consists of three main laboratory areas, a Phenotyping Laboratory, a Genotyping Laboratory and a PCR Laboratory. The provision of a suitable computer system is a major requirement, both for monitoring isolates received and for detailed analytical work.

Along with the Central Pathology Laboratory in SJH, NMRSARL has been involved in procuring a new computer system for a number of years and as part of this procurement, the special requirements of NMRSARL have been noted. However, all systems investigated to date would require extensive modification to accommodate NMRSARL's needs.

Finance

The budget allocated to the NMRSARL for the year to cover both pay and non-pay elements amounted to €257,975 representing a 5% reduction on the previous year. While some of the offset was managed through reduction in staffing, it presented a difficult challenge in maintaining the level of service for our users.

Education

Internal Training at NMRSARL

NMRSARL plays a prominent role in the education of laboratory staff, doctors and nurses throughout Ireland and this is achieved by regular feedback, presentations and reports.

In particular, NMRSARL staff gave lectures to undergraduate and postgraduate microbiology students in the Moyne Institute, TCD, the Department of Clinical Microbiology, TCD, and Dublin Institute of Technology and also made oral presentations at SJH Grand Rounds.

NMRSARL staff participated in continuous professional development through their attendance at laboratory talks, journal clubs and other relevant courses organized within St. James's. One member of staff continued through second year of the MSc in Clinical Laboratory Science through DIT, Kevin Street while another member of staff started a research PhD on the characterisation of sporadically occurring MRSA in Ireland through the Dublin Dental Hospital, TCD. The laboratory also facilitated a post graduate student from Trinity College in completion of a research project.

Scientific Meetings

The level of expertise and knowledge among staff of NMRSARL is maintained through the participation of staff at both national and international meetings, workshops and conferences. Throughout the year all staff continued their professional development through attending some of the following meetings:

- ECCMID
- Focus on Infection, TCD
- Staph GBI, TCD
- Academy of Medical Laboratory Science, Microbiology Advisory Body Meetings

As part of the NMRSARL's wider educational role, NMRSARL hosted its fourth national scientific meeting in collaboration with Professor Hilary Humphreys (with sponsorship from Novartis Ireland Ltd.) in the Royal College of Physicians. The theme of the meeting was 'MRSA: The continuing challenge' and was well attended by scientific and medical staff from throughout Ireland.

Research

Internal Research Projects

1. The monitoring of reduced susceptibility to glycopeptide among Irish MRSA isolates
2. The detection of the recently described new SCC*mec* element (SCC*mec*XI) harboring *mecC* in MRSA isolates from Irish hospitals
3. The development of a real time PCR assay for the detection of exfoliative toxins in *S. aureus* isolates.
4. Epidemiological typing of MSSA isolates causing BSI in Irish patients

Collaboration with Other Irish Reference Laboratories

NMRSARL maintains contact with colleagues in other Irish Reference Laboratories such as the Epidemiology and Molecular Biology Unit and the Meningococcal Reference Laboratory.

Committees

NMRSARL staff members sit on the Irish EARS-Net Steering Committee, the European Staphylococcal Reference Laboratories Working Group and on the Royal College of Physicians of Ireland's Policy Group on HealthCare-Associated Infection.

National Collaborative Work

The work described below has been undertaken in collaboration with Professor David Coleman, Dr. Anna Shore and their team at the Dublin Dental School, TCD:

1. Following a study that investigated the genotypes and SCC*mec* types and more recently the virulence and resistance genes of the predominant strains of MRSA in Ireland between 1971 and 2004, research is now focusing on the genotypes, SCC*mec* elements, virulence and resistance genes in infrequently-occurring, 'sporadic' and/or unusual MRSA isolates.

2. Investigation of the genetic mechanism of fusidic acid resistance in MRSA in Ireland.

3. Investigation of the usefulness of a *S. aureus* DNA microarray for genotyping MRSA isolates in Ireland and for enhancing discrimination and tracking of MRSA.

4. Characterisation of the genotypes, virulence and antimicrobial resistance genes of *pv*l-positive MRSA in Ireland.

5. Investigation of MRSA from animal populations for the presence of *mecC* in order to determine if isolates harboring this gene are a significant problem among MRSA isolates from animals in Ireland, or if the zoonotic spread of MRSA with this *mecC* are contributing to the burden of MRSA among humans.

6. Monitoring of the characteristics of novel and potentially emerging MRSA clones e.g. ST772-MRSA-V, and the evolution of existing MRSA clones in Irish hospitals and communities, such as subpopulations of ST22-MRSA-IV with enhanced virulence or extended antimicrobial resistance potential.

7. Investigating the role whole genome sequencing plays in the control of an MRSA or MSSA outbreak.

8. Investigating the genotypes, virulence and antimicrobial resistance potential of MSSA isolates associated with blood stream infections (BSI) and MRSA from BSIs in order to investigate why MSSA BSIs are increasing in Ireland while MRSA BSIs are decreasing.

International Collaboration

In 2006, NMRSARL participated in the EARS-Net *spa* typing project and the results of the work were published in January 2010.

The second phase of this project began in January 2011 with the collection of isolates. The aim of this is project to monitor any changes that may have occurred among the prevalent strains. The laboratory, with the support of the Dublin Dental Hospital, submitted data on the *spa* typing of these isolates, to the National Institute for Public Health and Environment, The Netherlands, who were co-ordinating the data from all participating European countries.

Discussions with staff from the Scottish, Danish and UK Reference Laboratories to organize an external quality assessment (EQA) programme between the four centers continued throughout 2013 and successfully resulted in the development of a suitable isolate exchange programme between the laboratories. The three laboratories also continue to provide assistance to each other on topics relating to MRSA specific to Ireland, England and Scotland such as local resistance and epidemiology of MRSA.

Publications involving staff of the NMRSARL

Shore AC, Tecklenborg SC, **Brennan GI**, Ehricht R, Monecke S, Coleman DC. (2013) Panton-Valentine Leukocidin-Positive *Staphylococcus aureus* in Ireland 2002-2011: Twenty-One Clones, Frequent Importation of Clones, Temporal Shifts of Predominant Methicillin-Resistant S. aureus and Increasing Multiresistance. J Clin Microbiol. 2013 Dec 26. [Epub ahead of print]

Kinnevey PM, **Shore AC, Brennan GI**, Sullivan DJ, Ehricht R, Monecke S, Slickers P, Coleman DC. (2013) Emergence of sequence type 779 methicillin-resistant *Staphylococcus aureus* harboring a novel pseudo staphylococcal cassette chromosome *mec* (SCC*mec*)-SCC-SCCCRISPR composite element in Irish hospitals. Antimicrob Agents Chemother, 2013 Jan; 57(1):524-31.

Posters involving staff of the NMRSARL

Leonard, FC, Abbott, YA, Burns, A, Coleman D.C., Leggett B, Brennan, G.I., Malhotra S, Markey B, Sabirova, J, and Shore A.C.. First identification of CC398 methicillin-resistant *Staphylococcus aureus* in Irish livestock: valuable lessons

Presented at the 3rd ASM-ESCMID Conference on methicillin resistant Staphylococci in Animals: Veterinary and Public Health Implications, 4–7 November 2013,Copenhagen, Denmark

Acknowledgements

NMRSARL would like to thank the departments in SJH who assist with the provision of basic services (Central Pathology Laboratory, Finance, General Support Services, Human Resources and Information Management Services). We especially thank the Microbiology Department for their continued support.

We would also like to thank Professor Hilary Humphreys for his service to the laboratory throughout the year.

Current Staff of the NMRSARL

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Gráinne Brennan	Chief Medical Scientist
Tanya Fleming	Medical Scientist
Sinead Saab	Medical Scientist
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Laboratory aspects of MRSA

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Infection prevention and control

Infection Control Team, SJH	01 416 2961

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