Epidemiology of multi-resistant *Acinetobacter baumannii* in Europe

Results of an ESGNI survey
(March 2010)

Christian Ruef, Zurich, Switzerland

Topics of presentation

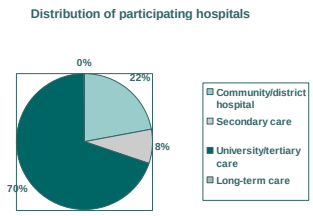
- Background
- Survey method and analysis
- Results
- Discussion, conclusions

Methods

- Preparation of questionnaire by members of ESGNI board
- Adaptation for online survey (Survey Monkey) by Henri Saenz & Adrian Baumeyer, ESCMID
- E-mail invitation to participate to all members of ESGNI (February 2010)
- Data analysis (March 2010)

Results

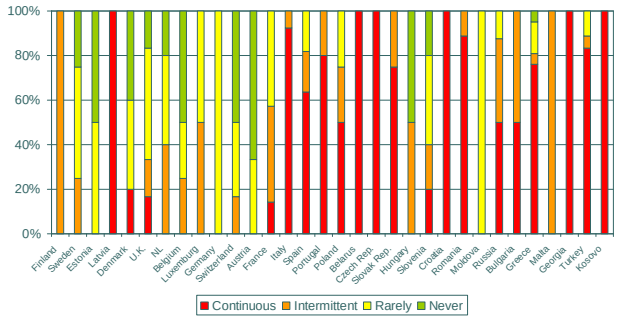
- 242 online replies received
  - 219 valid questionnaires



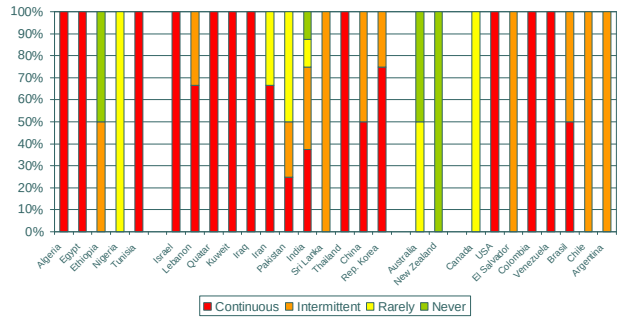
Distribution of hospitals providing polytrauma care

Hospital type	**Polytrauma care**	
	No	Yes
Community/district	23	30
Secondary	4	16
University/tertiary	31	137

Magnitude of multiresistant *Acinetobacter baumannii* problem in Europe



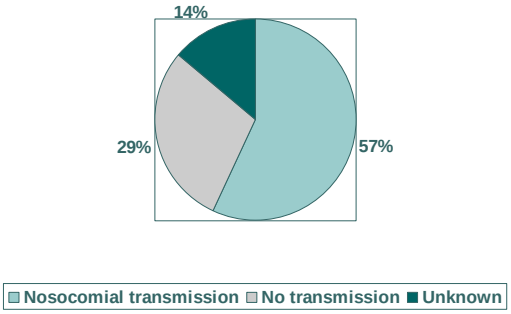
Magnitude of multiresistant *Acinetobacter baumannii* problem outside of Europe



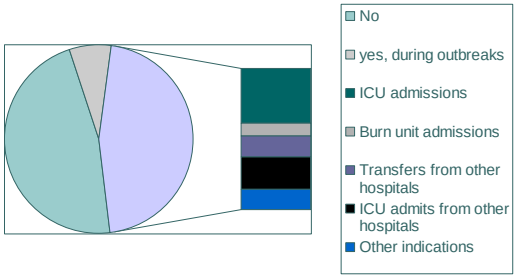
Reported number of cases in 2009

- **15‘440** (7982 accurate +7458 estimated)
- **Plus the following outliers:**
  - 17‘604 (one hospital in Thailand)
  - 20‘000 (one hospital in Athens, Greece)
  - 11‘111 (one hospital in Slovak Republic)
  - 12‘800 (one hospital in Brasil)

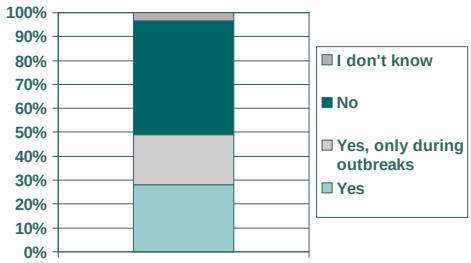
Proportion of hospitals reporting nosocomial transmission



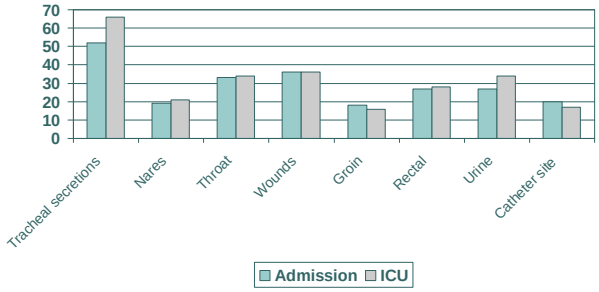
Do you perform admission screening for colonized patients with multiresistant *A. baumannii?*



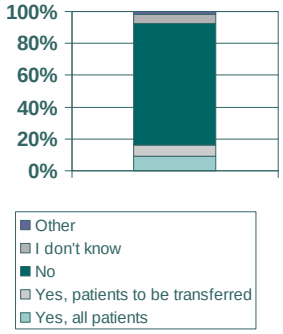
Do you perform screening in ICU patients?



Anatomical sites sampled during screening



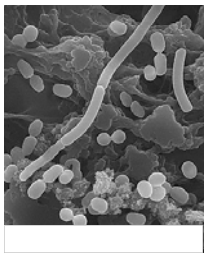
Do you screen patients at discharge?



- Hospital with admission screening:
  - 11 screen all pts.
  - 7 screen transfers
  - 20 don‘t screen
  - 5 don‘t know

Acinetobacter baumannii: *Pathogenetic and molecular features*

Jordi Vila
Hospital Clinic
Barcelona, Spain



Evolution of antimicrobial resistance in *A. baumannii* clinical isolates

	% Resistance					
Antimicrobial agents	1993	1996	2003	2004	2007	2007
Piperacillin/tazobactam	67	36	72	95	--	--
Ceftazidime	45	42	45	85	97	88
Imipenem	0	2	5	48	38	71
Ciprofloxacin	30	4	57	90	97	93
Amikacin	28	28	13	66	22	86

Vila J, Pachón J. (2008) Expert Opin. Pharmacother. 9: 587

Why does *A. baumannii* acquire multiresistance easily?

- Ability to survive in human and environmental reservoirs
- Intrinsic resistance of the microorganism
- Facility to acquire resistance

HABITAT

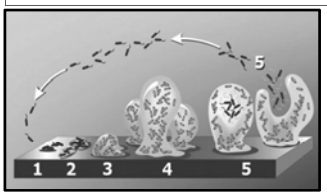
- Moist and dry environments
  - Hospital colonization (outbreaks)
    - Respiratory equipment, different sources….
  - Human reservoirs
    - Perineum, axila
    - High prevalence in stool of hospitalized patients during outbreaks

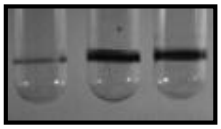
SURVIVAL IN THE ENVIRONMENT

- Studies of survival on dry surfaces
  - Outbreak strains
    - 26.5 days
  - Sporadic strains
    - 27.2 days

Jawad et al. (1998) JCM 36: 1938

Acinetobacter baumannii Biofilm



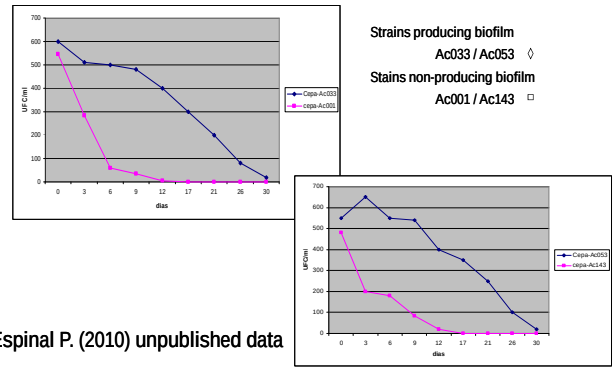


Biofilm: Congregation of bacterial cells irreversibly associated with a solid surface and enclosed within a polysaccharide matrix.

***In vitro* biofilm formation: liquid-air interface (ring structure)**

Possible explanation for the resistance to desiccation and disinfection.

SURVIVAL IN THE ENVIRONMENT



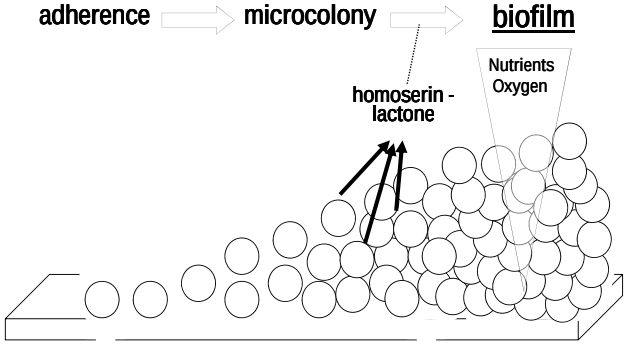
Strains producing biofilm
Ac033 / Ac053 ◊
Stains non-producing biofilm
Ac001 / Ac143 □

Espinal P. (2010) unpublished data

SURVIVAL IN THE ENVIRONMENT

- Studies of survival on dry surfaces
  - Biofilm-producing strains
    - 30 days
  - Non-biofilm-producing strains
    - 15 days

Espinal P. (2010) unpublished data



Tomaras et al. Characterization of a two-component regulatory system from *Acinetobacter baumannii* that controls biofilm formation and cellular morphology
Microbiology 2008; 154: 3398

- Biofilm formation depends on the production of pili assembled via the CsuAB-A-B-C-D-E chaperone-usher secretion system.
- Biofilm-deficient mutants presented a disrupted gene *bfmR* is required for the expression of the Csu pili chaperone-usher assembly system
- BfmR is part of a two-component regulatory system that plays an important role in biofilm formation

Loehfelm TW et al. Identification and characterization of an *Acinetobacter baumannii* biofilm-associated protein
J Bacteriol 2008; 190: 1036

- Bap protein – surface adhesin
- Transposon mutagenesis of the *bap* gene
  Results by Scanning electron microscopy show that it supports the development of the mature biofilm structure
- Involved in intercellular adhesion within the mature biofilm

Niu et al. Isolation and characterization of an autoinducer synthase from*Acinetobacter baumannii*
J Bacteriol 2008; 190: 3386

- *abaI* gene encoding an autoinducer synthase
- AHL signal directed was:
  N-(3-hydroxydodecanoyl)-L-HSL
- Disruption of this gene impaired the biofilm development since AHL- dependent quorum-sensing is required for biofilm maturation

Biofilm formation

Rodriguez-Baño et al. CMI (2008) 14:276

	Biofilm forming (n = 49)	Non-biofilm forming (n = 29)	P value
Mean age, years	55%	62%	0.08
Male gender	72%	78%	0.5
Underlying disease			
Non-fatal	74%	62%	0.5
Ultimately fatal	24%	32%	
Rapidly fatal	4%	6%	
Diabetes mellitus	10%	22%	0.1
Neoplasia	17%	28%	0.2
Chronic pulmonary disease	15%	28%	0.2
ICU treatment	26%	53%	0.01
Mean days of hospital stay	29%	22%	0.3
Mechanical ventilation	44%	52%	0.4
Previous antimicrobial agents	86%	84%	0.7
Aminoglycosides	43%	20%	0.06
Fluoroquinolones	21%	10%	0.2
Cephalosporins	46%	27%	0.09
Carbapenems	13%	17%	0.1
Type of sample			
Respiratory tract	25%	53%	0.01
Blood	10%	0%	0.07
Urine	32%	14%	0.06
Wound	27%	27%	0.8
Others	6%	6%	0.8

	Biofilm forming (n = 49)	Non-biofilm forming (n = 29)	P value
Imipenem	25%	47%	0.04
Ciprofloxacin	66%	94%	0.004
Doxycycline	65%	60%	NS
Ceftazidime	73%	83%	NS
Sulbactam	39%	27%	NS
Gentamicin	80%	77%	NS
Tobramycin	76%	73%	NS
Rifampicin	0%	3%	NS

	Biofilm forming (n = 49)	Non-biofilm forming (n = 29)
IV catheter related infect.	3	0
Foley-related UTI	6	0
VA respiratory tract infec,	5	8
Non-VA RTI	1	0
Skin and soft-tissue inf.	4	5

Vallenet D et al. Comparative analysis of *Acinetobacters:* Three genomes for three lifestyles

PLoS ONE 2008; 3: e1805

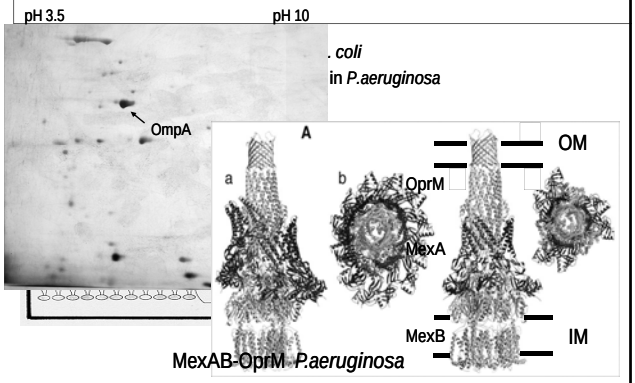
	A. baylyi ADP1	*A. baumannii* AYE	*A. baumannii* SDF
Com genes	Yes	Yes	Yes*
Csu genes	No	Yes	No

* Disrupted

Why do *P.aeruginosa* and *A. baumannii* acquire multiresistance easily?

- Ability to survive in human and environmental reservoirs
- Intrinsic resistance of the microorganism
- Facility to acquire resistance

Intrinsic resistance



. coli
in *P.aeruginosa*

MexAB-OprM *P.aeruginosa*

Choi L et al. *Acinetobacter baumannii* invades epithelial cells and outer membrane protein A mediates interaction with epithelial cells
BMC microbiology 2008; 8: 216

- *A. baumannii* adheres to and invades epithelial cells.
- OmpA plays a major role inthe interactions with epithelial cells.

Constitutive expression of efflux pumps

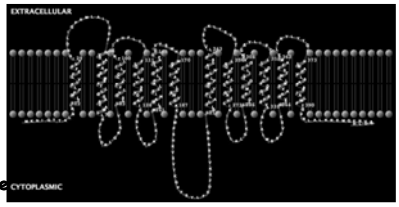
Antimicrobial Agent	adeIJK	ΔadeIJK
Ticarcillin	8	1
Cefotaxime	8	1.5
Tetracycline	48	4
Levofloxacin	12	6

Characteristics of CraA

(Roca et al. AAC (2009) 53:4013)

- **Efflux pump belonging to the Major Facilitator Superfamily**

CraA
(*A. baumannii*)



- **Substrate: Chloramphenicol**
- **12 Transmembrane α-helix domains**

Antimicrobial susceptibility

Antimicrobial agent	ATCC 19606	JVAB01 (Orf3 -)	JVAB01 + pJV103 (Orf3 +)
Tetracycline	6	6	96
Nalidixic acid	12	12	12
Ciprofloxacin	0.25	0.25	0.25
Norfloxacin	6	6	6
Imipenem	0.75	0.75	0.75
Clindamycin	>256	>256	>256
Erythromycin	1.5	1.5	1.5
Chloramphenicol	>256	2	196
Chloramphenicol + PAβN [a]	32	1.5	16

Pump Inhibitor PAβN

Expression of efflux pumps in *A. baumannii*

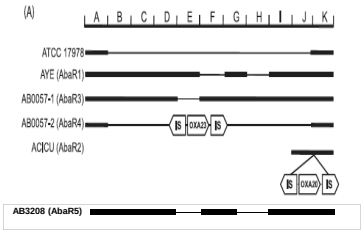
Efflux pumps	Q	T	AG	CM	β-lactams
AdeIJK	+	+	-	+	+
AdeABC	+	+	+	+	+

Why does *A. baumannii* acquire multiresistance easily?

- Ability to survive in human and environmental reservoirs
- Intrinsic resistance of the microorganism
- Facility to acquire resistance
  - Resistance islands
  - Integrons
  - Transposons
  - Plasmids

Resistant islands found in *A. baumannii*

Resistant islan AYE 86 Kb (45 rg)



A = Transposon
B = trkA, trxB
C = arsenate resist. Operon
D = ISPpu12
E = AYE specific sequence
F = Ab0057 specific seq.
G = *tetR, tetA, cat*
H = Tn3 including bla_{TEM}
I = *aphA1, aac3, aadDA1*
J = ISPpu12
K = sulfate permease

Shaikh F et al. ATPase genes of diverse multidrug-resistant *Acinetobacter baumannii* isolates frequently harbour integrated DNA

J Antimicrob Chemother 2009; 63: 260

- 41 of 50 *A. baumannii* clinical isolates appeared to contain a disrupted ATPase gene
- 8 of the 10 ATPase-negative isolates investigated in detail had ATPase genes disrupted with AbaR1-like flanking regions

Prevalence of RI in *Acinetobacter baumannii*

- 82 *A. baumannii* clones
  - 54 (66%) PCR (-) for the gene encoding ATPase
  - 28 (34%) PCR (+) for the gene encoding ATPase

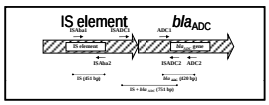
Region	ATPase (-)	ATPase (+)
A transposasa	0%	48%
E *aadB*	7%	100%
F *topA*	0%	22%
G *tetA*	57%	39%

Ceftazidime resistance

- Overproduction of chromosomal cephalosporinase – AmpC
- Extended-spectrum β-lactamases

Chromosomal cephalosporinase

- *A. baumannii*
  - Non-induced
  - Expressed at low-levels
  - Overexpressed as a result of a genetic event



40.5% identity between AmpC of *P. aeruginosa* and *A. baumannii*

Synthesis of β-lactamases in *A. baumannii*

- Broad-spectrum
  - TEM-1 and -2
  - CARB-5
  - OXA -21
- Extended-spectrum
  - *PER -1
  - SHV-12
  - TEM-92
  - CTX-M-2
  - VEB-1
  - *OXA-ESBLs (oxa-37)
    - » * Moderate or poor inhibition by clavulanic acid

Carbapenem resistance

- Decrease in Omp(s) expression
- Synthesis of β-lactamases.
- Changes in PBPs.

Outer membrane permeability

- Loss of an outer membrane protein
  - 33-36 Kda Clark RB (1996) JAC 38: 245
  - 22 and 33 Kda Bou et al. (2000) JCM 38: 3299
  - 29 Kda (CarO) Limansky et al. (2002) JCM 40: 4776; Mussi et al . (2005)
  - 43 Kda Dupont et al. (2005) J Prot Res 4:2386
    - 38% amino acid identity with OprD

Carbapenemases

- *A. baumannii*
  - Oxacillinases: 4 groups (Class D)
    - OXA-24-like (OXA-25, OXA-26 and 0XA-40)
    - OXA-23-like (OXA-27, OXA-49)
    - OXA-51-like (very heterogeneous)
    - OXA-58
    - OXA-143
  - Metallo-β-lactamases (Class B)
    - IMP-1 to 6 and 11
    - VIM-2
    - SIM-1

Fluoroquinolone resistance

- Changes in the protein targets.
  - DNA gyrase
  - Topoisomerase IV
- Reduction in the accumulation of the quinolone.
  - Increase in active efflux system(s) mostly AdeABC

MIC (mg/L)		Amino acid changes			
		GyrA		ParC	
CIP	NAL				
0.12 - 1	2	Ser-83	Asp-87	Ser-80	Glu-84
4-64	256	Leu	Asn	Leu	Glu
32-128	>1024	Leu	Asp	Leu	Glu

adeABC, others?

Aminoglycoside resistance

- Major AMEs found in *A.baumannii*
  - aacC1* Gm
  - aadA* Sm, Spc
  - aadB* Gm, Tob, Kan
  - aacA4* Tob, Amk
  - aphA1 Km, Neo
  - aphA6 Km, Neo, Amk

* Integron located genes

- Overexpression of AdeABC

What antibiotics are commonly used to treat *Acinetobacter* infections?

- Therapeutic options:
  - Carbapenems
  - Minocycline
  - Colistin

Adams MK et al. Resistance to colistin in *Acinetobacter baumannii* associated with mutations in the PmrAB two-component system
Antimicrob Agents Chemother 2009;53:3628

- Mutations in genes encoding the two-component system proteins PmrA and/or PmrB are involved in colistin resistance.
- A colistin susceptible revertant of one colR mutant carried a partial deletion of *pmrB*

What antibiotics are commonly used to treat *Acinetobacter* infections?

- Therapeutic options:
  - Carbapenems
  - Minocycline
  - Colistin
  - Tigecycline

Acinetobacter baumannii. Activity of tigecycline

	Resistance % Break-point ≥ 8
Capone et al. JAC (2008) 62:422	3.7
Dizbay et al. IJAA (2008) 32: 29	25.8
Yau W et al. J Infect (2009) 58: 138-144	10
Song and Koo IJAA (2009) 33: 287	2.5

CONCLUSIONS

- The emergence of XDR and Pan-resistant *A. baumannii* is a fact.
- The high resistant rates are associated with several factors among which the intrinsic resistance, acqusition of RI and survival in the environment should be highlighted
- The need for therapeutic alternatives is obvious

Thanks

Author: B. Cookson (London, UK)

Title: **Multiresistant *Acinetobacter baumannii*: Infection control guidelines**

Infections and colonisation with multi-resistant *Acinetobacter baumannii* has become a commoner issue in many countries over the last few years. However, there is still debate as to the burden of disease and it is interesting that there were no national guidelines evident when I searched for these in 2006. I thus convened a working group in England with representatives from the UK infection control societies that explored the possible approaches that could be used. The recommendations of the group were informed by two meetings of infection control teams from over 100 affected and other interested English hospitals and are very practically orientated. They will be presented and can be found at: http://www.hpa.org.uk/infections/topics_az/acinetobacter_b/guidance.htm I will reflect with the workshop on the resonance of the recommendations with the findings of the ESGNI survey and gleanings from the literature from more recent outbreaks

.

Multiresistant *Acinetobacter baumannii* Infection control guidelines

Professor Barry Cookson
Chairman of ESGNI

- **Depts. of Health Policy & Tropical & Infectious Disease, London School of Hygiene & Tropical Medicine.**
- **Dept Infectious Disease, Imperial College, University of London**

Outline of Lecture

- Guideline development process
- Provided an outline of the key points of the HPA Acinetobacter baumannii prevention and control guidelines to the audience
- (Reflection on results of questionnaire (Lecture 1)
- Pose questions to the audience to explore views on key issues

Pragmatic Guideline Development Processes

- Many Countries starting point CDC rigorous assessment of the literature and categorisation of evidence base for recommendations
- Some interact with IC & Healthcare Professional organisations, Patient advocate organisations etc
- Audit-informed, user-derived policy based statements e.g. PHLS Clinical Audit Project (widely quoted in UK 1st EPIC Guidelines)
- Statements were easily applicable in other EU Countries using the "HARMONY" approach (see Cookson et al, *J Hosp Infect*. 2009;72: 202-210)

Cookson – Infection Control Guidelines

ADAPT approach
Int. J. Qual Hlth Care 2006; 18:167–176

- Propose a stepwise pragmatic approach to trans-contextual adaptation
  - Searching for existing guidelines
  - Quality appraisal
  - Detailed analysis of the coherence between the evidence and the recommendations
  - Adaptation of the recommendations to the target context of use, taking into account :
    - Organization of the health care system
    - Cultural context.

HPA Multi-Resistant *Acinetobacter baumannii* (MRAB) Guidance

- Underpinning principles were covered in many existing DH/Inspection/Clinical Governance systems
- These included, for example:
  - Management commitment to Inf Prev and Control (IPS)
  - Antibiotic policy in place, audited and reviewed
  - Commitment of all staff to IPC e.g. IPRs, PDPs
  - Voluntary bacteraemia surveillance and review of cases, especially on high risk units
  - Local policy development based on Guidelines/Guidance, regular audit and updating

Literature Review resonated with CDC

- Same issues as CDC 18m later
- Medline and PubMed searches
- No papers with rigorous design to disentangle the many complex interventions*
  - Variable and quasi experimental design
  - Limited follow-up
- Outbreaks studies reduced rates: median of 7-8 interventions!
- Unpicking these impossible and comprised:
  - Administration and Training
  - Surveillance
  - Antimicrobial Stewardship
  - IC Precautions; Decontamination; Environment

* See “ORION”: Google “Orion IDRN”

Cookson – Infection Control Guidelines

HPA MRAB Guidance

- No funding for a systematic review
- No recognised guidelines internationally at this time
- Multi-Professional Infection Control group drafted guidance
- June 2005 & Feb.2006 meetings
- Each had ~80 attendees from ~60 hospitals
- Focus on what was practical
- Finalised June 2006 after consultation via the internet/J Hosp Infection notification

Workshop Example

- Equipment significant problems with 40% of the audience
  - Issues with time for staff to ensure equipment decontaminated
  - No sealed computer keyboards
  - Need for more cleanable equipment
  - Decontamination teams as in Belgium

Multi-Resistant *Acinetobacter baumannii*

- Definitions varied in the literature
- Multiresistant are resistant to any aminoglycoside (*e.g.*gentamicin) AND to any third generation cephalosporin (*e.g.* ceftazidime, cefotaxime): "MRAB" We were of the opinion that these should be taken more seriously than in some English hospitals
- MRAB additionally resistant to carbapenems (imipenem and/or meropenem) were termed "MRABC"
- We will use "MRAB/C" in these slides!

Cookson – Infection Control Guidelines

Single Colonised/Infected MRAB/C Patient

- Ideally contact isolation precautions in a side-room
- Infection control and antimicrobial prescribing reviewed
- Risk assessment of the case should be performed and numbers and results of clinical specimens from other patients on the ward/unit reviewed to inform whether screening of other patients is indicated.

Epidemiological Case Review

- Case definition decided including MRAB/C antibiograms
- Colonisation/Infection Risk factors reviewed e.g.
  - Intensive care/Burns unit admissions
  - Prolonged length of hospital stay
  - Surgical/Other wounds
  - Broad spectrum antibiotic treatment including carbapenem usage
  - Devices: urinary/vascular catheters and ventilation
  - Parenteral nutrition

"House Keeping" and Decontamination

- Instruments or equipment (*eg* writing materials, sphygmomanometers, stethoscopes,lifting slings, and resuscitator bags) should be designated for affected patients.
- If possible, single patient use items are to be preferred.
- Alternatively, such items should be decontaminated suitably before use on another patient.
- Special attention should be paid to ventilator circuits, suction catheters and humidifiers

Cookson – Infection Control Guidelines

Minimise Stock

- Stock items become contaminated around a patient
- After patient departure decontaminate these
- ALL unused disposable items such as packets of unopened gloves, needles etc, should be discarded
- Stocks of these should thus be kept to the minimum needed for the care of that patient, so that wastage is minimised

Post Discharge "Terminal" Cleaning/Disinfection

- According to the local disinfection policy (see later)
- Remove not redistribute dirt e.g. use of damp dusting, vacuum cleaners with high efficiency filters fitted to their exhausts and single use, or thermally disinfectable, mops
- Attention to horizontal surfaces and dust collecting areas, bedclothes, curtain rails, beds, tables, ventilators, sinks, doorknobs, and telephones.
- Curtains should be changed or if a common divider between two beds, it should be changed when one patient leaves
- Easily decontaminated computer keyboards, for example those with flat sealed membranes, should be used.
- Electrical equipment that generates static need particular attention.

Disinfection

- The Infection Control Team should make a decision on whether a disinfectant is needed:
- Chlorine-based agents (*eg* sodium dichloroisocyanurate) at 1,000 ppm available chlorine +/- a compatible anionic detergent
- 70% alcohol if corrosion problems
- Same for pillows, duvets, mattress covers and mattresses or discarded if damaged.
- Specialist cleaning for therapy beds (*e.g.* high quality thermal washing/disinfection)
- Clean Special mattresses after patient use according to manufacturers' instructions.

Cookson – Infection Control Guidelines

More than One MRAB/C

- Convening Outbreak Team > one patient isolate of a similar antibiogram on the same unit/ward
- Regular outbreak meetings with all relevant staff and senior managers
- Feedback key information, answer queries, review and modify as appropriate interventions

More than One MRAB/C

- Agreed Case definitions Document all infected/colonised patients:
  - Dates of admission and discharge
  - Ward and bed locations
  - Time line analysis of patient activity such as movement to, and from, theatre, and for bronchoscopy

More than One MRAB/C

- A cluster of MRAB/C cases should trigger an audit and review of these measures and root cause analysis may also help identify and address the factors contributing to acquisition and transmission of infection in a hierarchical way
- CDC MDRO GNRs Process Control charts or other methods of reviewing cases

Cookson – Infection Control Guidelines

Risk assessment

- Performed for all cases
- Isolation strategy & other interventions agreed with all the Infection Control Team, relevant healthcare workers, and senior managers

Risk assessment

- All infection control procedures should be reviewed and reinforced or corrected, including:
  - hand decontamination
  - correct use of gloves
  - suctioning practices
  - device usage
- Some centres use patient antiseptic decontamination regimens e.g.chlorhexidine or triclosan, to reduce the bacterial loads on patients.
  ("CDC for GNRs unresolved issue")

Antibiotic Stewardship

- Treatment use local information on MRAB/Cs (trends/ASTs)
- Review prescribing if cluster of cases
- Audit/Feed Back/Discuss usage if continuing cases
- Try to minimise prescribing, especially broad spectrum agents
- Specific recommendations regarding restriction of named antibiotic classes, such as carbapenems for MRAB/C, may be appropriate in some circumstances, but will need local assessment and review.

Cookson – Infection Control Guidelines

Patient and environmental screening strategies

- Agreed locally including:
  - monitoring the effectiveness of interventions
  - Periodic/Discharge screening
  - Screening sites that have been advocated include the nose, throat, perineum and any wounds, sputa, tracheostomy sites, the hairline (to detect dispersers), faeces and antecubital fossa
  - Environmental contamination if continuing cases after decontamination

Surveillance and Duration of MRAB Carriage

Marchaim et al, *J Clin Micro* 2007:45 1551-5

- Used sensitive broth enrichment culture
- 22 patients 55% sensitivity when screened Nose/Throat/Rectum/"Skin" [Ax/ACF/Groins]
- Each site ~33% sensitivity!
- NSD between sites or time since clinically positive
- 17% of patients carried it for up to 42m
- Many issues with study e.g. only clinically positive patients screened, low numbers

Reference Laboratories Submission

- Of appropriate isolates for further characterisation and typing
- Explore epidemiological hypotheses
- Evaluate interventions

Continuing Cases After Interventions

- Consider closing and emptying the affected units
- Cohort affected patients in distinct areas
  - Totally separate ancillary facilities e.g. sluices and cleaning equipment.
  - Recommended own nursing staff
- Some extend to own physiotherapists and medical staff.
- Where impossible, even more important nursing staff enforce strict infection control discipline for all visiting staff.

Post Outbreak

- Consider closing affected wards
- Perform thorough decontamination of the environment and all equipment, as part of a terminal clean coordinated by the ICT/Link Staff
- Electrical equipment, mattress and pillow covers and high surfaces such as air vents, will often require cleaning by none cleaning staff
- Some outbreaks related to staff pressure, particularly nursing and cleaning: identify on the Trust risk register

Other Procedures

- Notify ICT/Clinicians of MRAB/C patients (including those screened and thought to be clear) before transferred to another hospital so aware of the patient's MRAB/C status and the context of the MRAB/C exposure

Cookson – Infection Control Guidelines

CDC Call for Action