



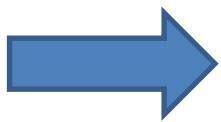
How to detect and investigate outbreaks in healthcare settings ?

Petra Gastmeier

Outbreaks in healthcare settings

- = occurrence of more infections as expected in a given time period and in a specific area (above the endemic level)
- a common source is expected
- Incidence:
 - About 1 outbreak / 150 beds / year
 - 4% of nosocomial infected patients are infected associated with an outbreak

Wendt/Herwaldt in Wenzel 3rd edition 1993



Charité: about 20 HCAI outbreaks per year,
about 100 nosocomial infected patients associated with outbreaks

Overview of notified outbreaks 2012 (without norovirus)

Campus	Ward	Pathogen	Patients (Infections)
CBF	S44i	P.aeruginosa (MR)	6 (6)
	S32B	P.aeruginosa	3 (1) k.A.
CCM	MNO-107i/108i	S.aureus (toxinprod.)	17 (5)
	M106i	A.baumannii (MR)	5 (5)
	M127	CDI	4 (4)
	MAN 101i	CDI	2 (2)
	MNO 107i	S.hämolyticus	2 (2)
	MAN 103i	S.marcescens	3 (2) k.A.
	MNO 107i/108i	K.pneumoniae (ESBL)	4 (1) k.A.
CVK	W43W	P.aeruginosa	2 (2)
	WNO 32i	S.marcescens	22 (7)
	WAN S8i	K.pneumoniae (KPC)	5 (2)
	WNP S47i	K.pneumoniae (OXA48)	4 (2)

13 outbreaks, 41 HCAI

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How to detect outbreaks?

Identification of outbreaks

- By the microbiology lab
- By infection control nurses (during surveillance)
- By health care workers on the wards



● SERRATIEN-AUSBRUCH

Keim-Alarm an der Charité

21.10.2012 | Mindestens sieben infizierte Frühgeborene, ein Todesfall: Auf der Neugeborenen-Intensivstation des Virchow-Klinikums der Charité ist offenbar eine Serratien-Infektionswelle ausgebrochen. Jetzt gilt Aufnahmestopp für die Station. [mehr >](#)

This outbreak was in the news of each German TV programme and all newspapers for at least one week

Serratien an der Charité

Auch Mütter könnten Quelle des Keims sein

von Annette Kögel



Sind die Keime über Cremes oder Lotionen in die Klinik gelangt? - FOTO: DPA

An der Charité werden noch immer mehrere Babys behandelt, die mit Serratien besiedelt sind. Bei der Suche nach der Herkunft der Keime haben Experten inzwischen eine neue Vermutung.

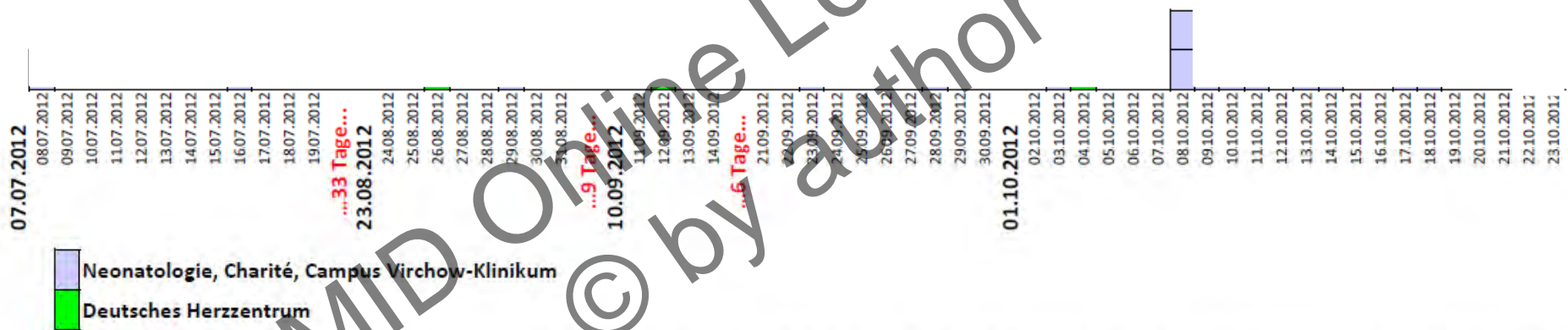
Empfehlen Twittern

Bei der Erforschung der Herkunft der Serratien-Keime in der Charité schließen die Experten nicht aus, dass

Epi curve (Neonatology Charite)

Information by a physician of the hygiene institute
Two BSI cases

Anhang IV - Epikurve (Fälle nach Tag des Erregernachweises)



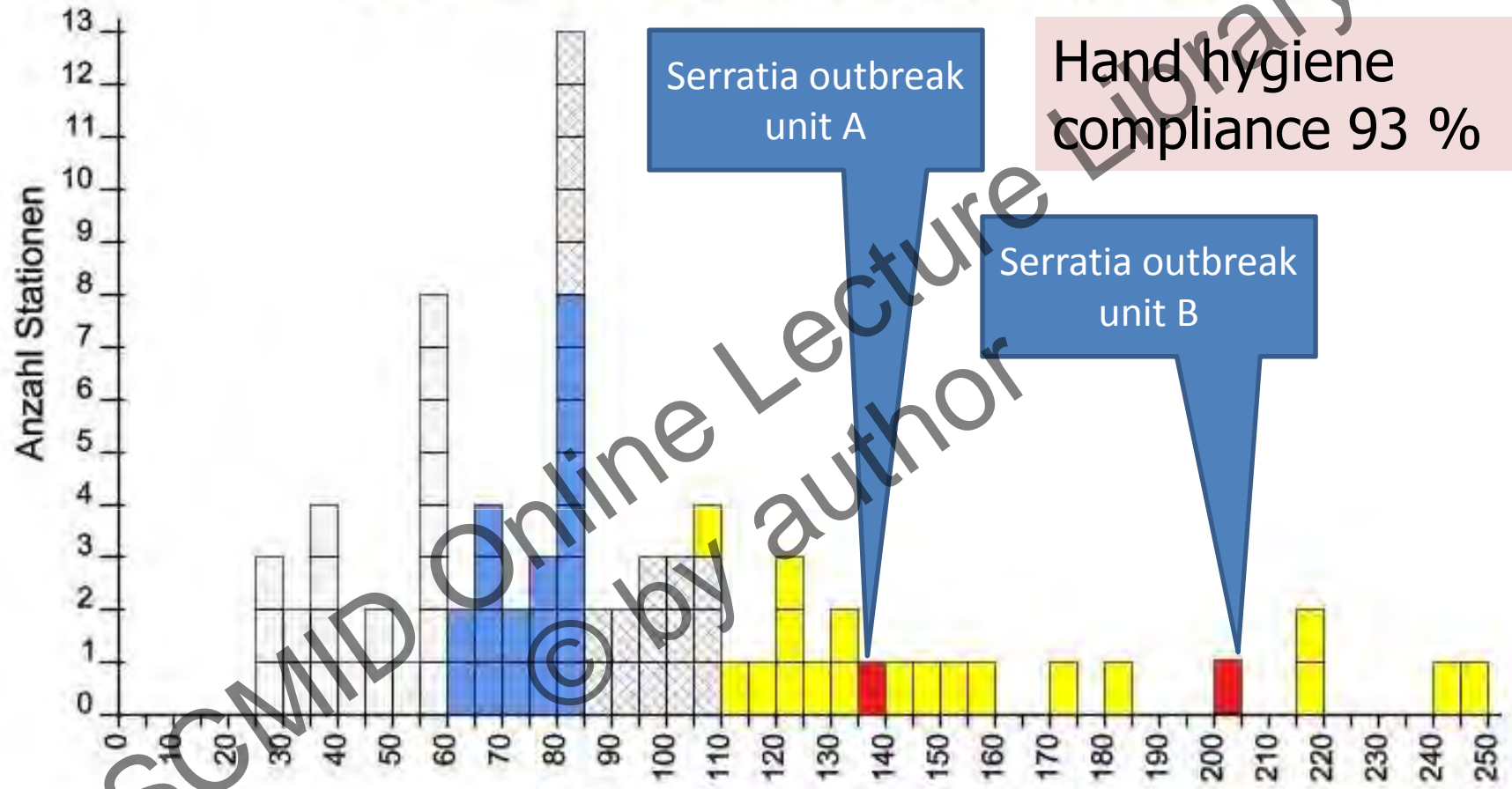
Aufgrund des ausgeprägt protrahierten Verlaufs des Ausbruchs mit lediglich sporadischen Fällen zwischen dem 08.07.2012 und dem 27.09.2012 wurden wegen der besseren Darstellbarkeit Lücken in der normalen Tagesfolge mit Angabe der ausgelassenen Anzahl von Tagen besonders gekennzeichnet (daher Maßstabsverzerrung beachten)

Data of the German surveillance system for neonatal ICUs

(NEO-KISS, 229 neonatal departments participating)

	Number of VLEW infants 2011	Standardized infection ratio (SIR)
Neonatal department 1 (CVK)	115	0.92
Neonatal department 2 (CCM)	60	0.57

Stratifizierung: Intensivstationen / Neonatologie



Distribution of hand rub consumption in German neonatology units (ml/patient day)

Q1: 60,00 Median: 83,00 Q3: 109,00

Legende

□ bedeutet Stat. mit einem HD-Verbrauch in ml pro Pat.-Tag \leq Q1, ■ \leq Median, ▨ \leq Q3 und ■ $>$ Q3.



Charité
Neonatology
Department
CVK

Unit A: Intensive care unit with 16 incubators

Unit B: Intermediate care unit with 18 incubators

Unit C: Special care unit with 16 incubators/beds

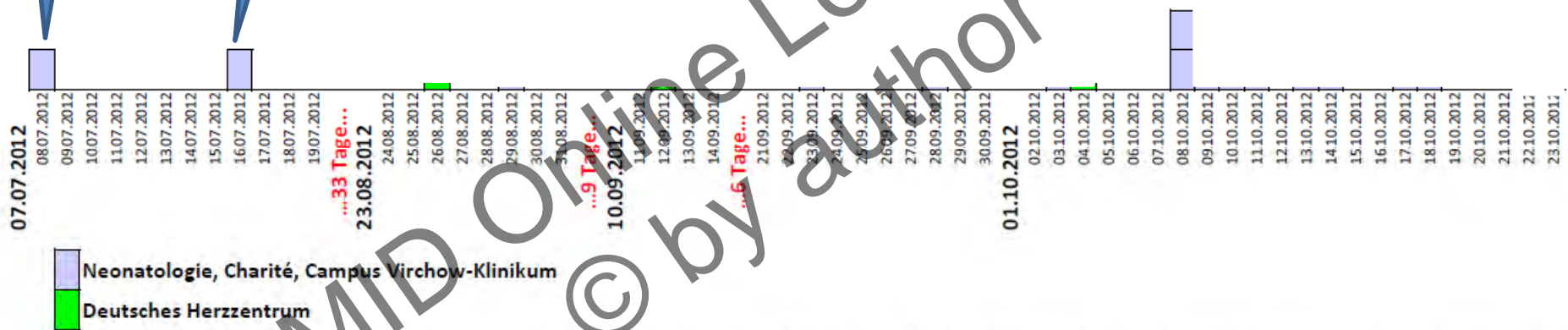
Total: 50 beds (mainly for VLBW infants)

Mother with amnion infection syndrome

Contact infant

Information by a physician of the hygiene institute

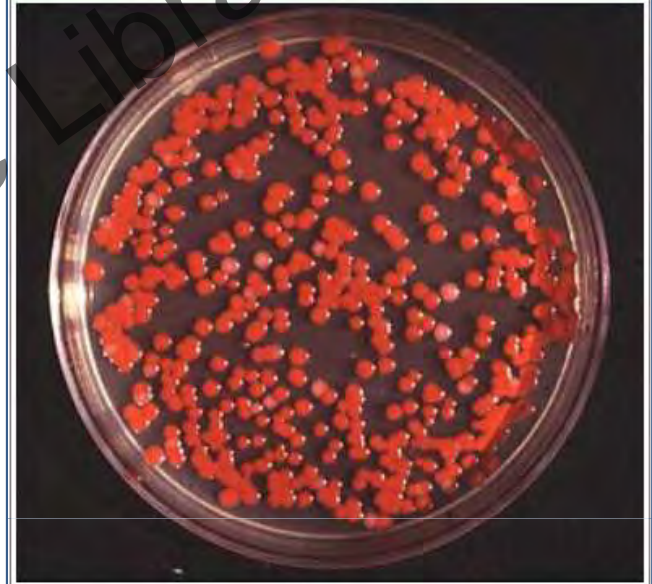
Anhang IV - Erkennungskurve (Fälle nach Tag des Erregernachweises)



Aufgrund des ausgeprägt protrahierten Verlaufs des Ausbruchs mit lediglich sporadischen Fällen zwischen dem 08.07.2012 und dem 27.09.2012 wurden wegen der besseren Darstellbarkeit Lücken in der normalen Tagesfolge mit Angabe der ausgelassenen Anzahl von Tagen besonders gekennzeichnet (daher Maßstabsverzerrung beachten)

Reference strain

Serratia marcescens



Results of AFLP

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Immediate empirical measures

Information of all relevant persons in the institution

- Hospital director (enough staff ?, media?)
- Microbiology lab (collecting strains, additional samples, typing?)
- Cleaning staff (enforced cleaning measures)

Establishment of an outbreak team

Information of the local health authorities ?
(according to the law)

Immediate empirical measures

For example

(according to the probable transmission routes):

- Screening of all patients on the ward, at least once, perhaps ongoing
- Enforcement of hand hygiene, gloves and gowns
- Education of the HCW
- Stop for new admissions, avoiding of patient movements as far as possible
- Observation of the procedures on the ward

Epi curve (Neonatology Charite)

Anhang IV - Epikurve (Fälle nach Tag des Erregernachweises)



Aufgrund des ausgeprägt protrahierten Verlaufs des Ausbruchs mit lediglich sporadischen Fällen zwischen dem 08.07.2012 und dem 27.09.2012 wurden wegen der besseren Darstellbarkeit Lücken in der normalen Tagesfolge mit Angabe der ausgelassenen Anzahl von Tagen besonders gekennzeichnet (daher Maßstabsverzerrung beachten)

No further cases occurred after implementation of infection control measures

How to investigate outbreaks?

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Outbreak investigations

- Sometimes spontaneous limitation without investigation
- Often outbreaks can be finished by empirical methods
- Outbreak investigations are necessary if
 - Nosocomial infections with high mortality or morbidity
 - Multiresistant or rare pathogens
 - Ongoing outbreaks despite intervention measures

Objective of the investigation

- Identification of the causing pathogen
- Identification of the reservoir
- Identification of the mode of transmission
- Elimination of the reservoir and stop of transmission
- Prevention of further outbreaks

Outbreak investigation

1. Descriptive Study:
(Location, time, patients involved)
2. Analytical study:
(Cohort or case control study)

Confirmation of diagnosis and case definition

- Diagnosis
 - Infection or colonization
 - Contamination
(during taking swabs, transport or laboratory)
- Case definition
 - Based on type of infection and symptoms and/or pathogens
 - Including timely association, place and patients concerned

Example: Each *S. marcescens* case in the period from July to February 2013 in the neonatology department or the Heart Center

Case definition

- Can be adjusted during the course of the outbreak investigation
 - Surgical site infection (SSI)
 - SSI by MRSA
 - SSI by MRSA t002

Example: Each *S. marcescens* case in the period from July to February 2013 in the neonatology department or the Heart Center with strain A

Literature search

Definition based on
pathogens

- Reservoir?
- Symptoms?

Definition based on
Symptoms

- Pathogens?

- Known transmission routes?
- Frequent factors causing these outbreaks (e.g. specific risk factors)

http://www.outbreak-database.com



Outbreak Database
Worldwide Database for Nosocomial Outbreaks
Beta Release

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ONLY PUBLISHED OUTBREAKS ARE IN THE DATABASE



serratia neonat*

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Your query was: **serratia neonat***

47 Results of 2908 found. (Query date: 2013-02-16 11:40:08 (UTC+00:00:00))

Journal - View

#	Ranking (in %)	PDF / HTML	Matchcode [MC]	Title [TI]	Author [AU]	Language [LA]	PublicationType [PT]	StudyType [ST]	Reference [RE] ([RV])	Year [RY] <input checked="" type="checkbox"/>	ArticlesRelated [AR]	FurtherOutbreaks [FO]	Comments [CS]	
1	26		Serratia-2009-Gul-2497	An Outbreak of Serratia marcescens Septicemia in Neonates	Guler E Davutoglu M Ucmak H	English	report	case report	Indian Pediatr. (46)	2009	0			http://www.ncbi.nlm.nih.gov/ordinalpos=32&itool=En
2	22		Serratia-2009-Buf-2503	Outbreak of Serratia marcescens in a neonatal intensive care unit: contaminated unmedicated liquid soap and risk factors	Buffet-Bataillon S Rabier V Bétrémieux P	English	report	case control study	J Hosp Infect. (72)	2009	0			http://www.ncbi.nlm.nih.gov/ordinalpos=19&itool=En

„Group by” function:

It is possible to order the outbreaks e.g. according to the source (index patient, personal, environment etc.)



serratia neonat* soap

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Journal - View

#	Ranking (in %)	PDF / HTML	Matchcode [MC]	Title [TI]	Author [AU]	Language [LA]	PublicationType [PT]	StudyType [ST]	Reference [RE] ([RV])	Year [RY]	ArticlesRelated [AR]	FurtherOutbreaks [FO]	Country [CO]
1	34		Serratia-2009-Buf-2503	Outbreak of <i>Serratia marcescens</i> in a neonatal intensive care unit: contaminated unmedicated liquid soap and risk factors	Buffet-Bataillon S Rabier V Bétrémieux P	English	report	case-control study	J Hosp Infect. (72)	2009	0		
2	31		Serratia-2008-RAB-2462	Hand washing soap as a source of neonatal <i>Serratia</i>	Rabier V Bataillon S Jolivet-Gougeon A et al	English	original	case report	Acta Paediatr. (97)	2008	0		

Storage of isolates and probable sources

- According to the data of the literature
- Investigation of probable sources and collection of isolates
- Contact with the microbiology laboratory:
 - Collection of all patient isolates
 - Investigation of all contact patients

Serratia outbreak: Serratia was often identified from soap



All soap dispensers were tested and all private soaps from the mothers .

Environmental samples during the Serratia outbreak 2012

- About 700 environmental samples,
- all negative with one exception:
The control knob of the suctioning machine during work, but no failure of disinfection (direct patient environment according to the five moments of hand hygiene)
- No identification from soap or shampoo

Producing an epidemic curve

- Identification of all cases

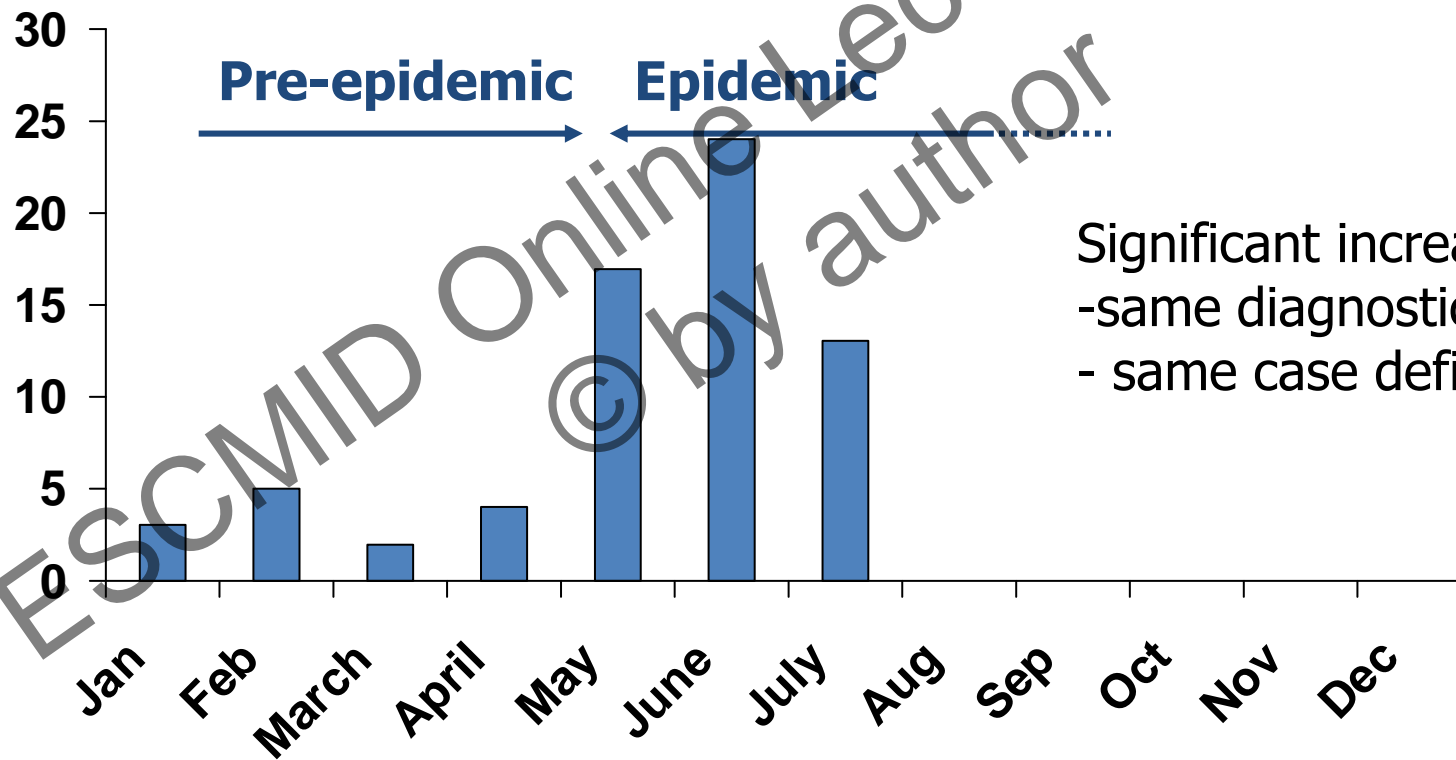
- Laboratory data
- Patients charts
- Interviews (staff, others)

- Creating the curve

- Y axis: number of cases
- X axis: time intervall

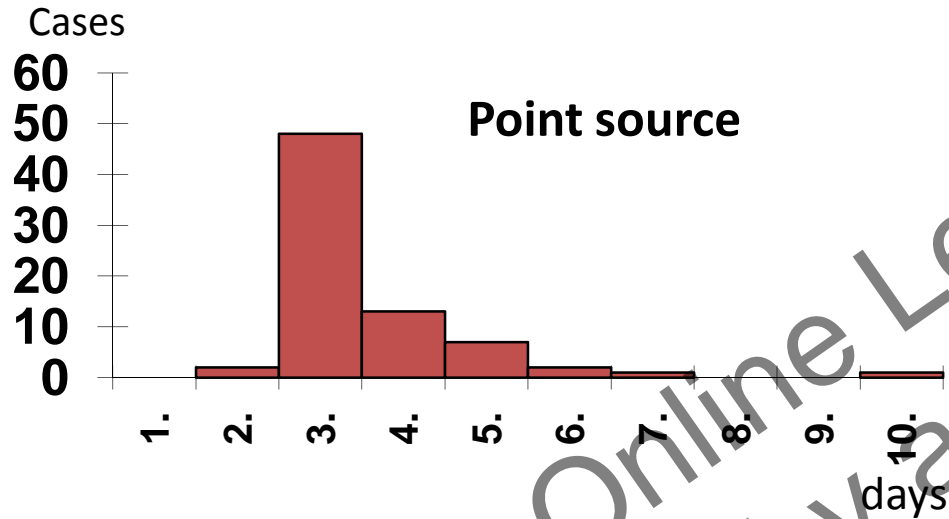
The time interval depends on incubation period + duration of the outbreak

Comparison of the epidemic period with the pre-epidemic period

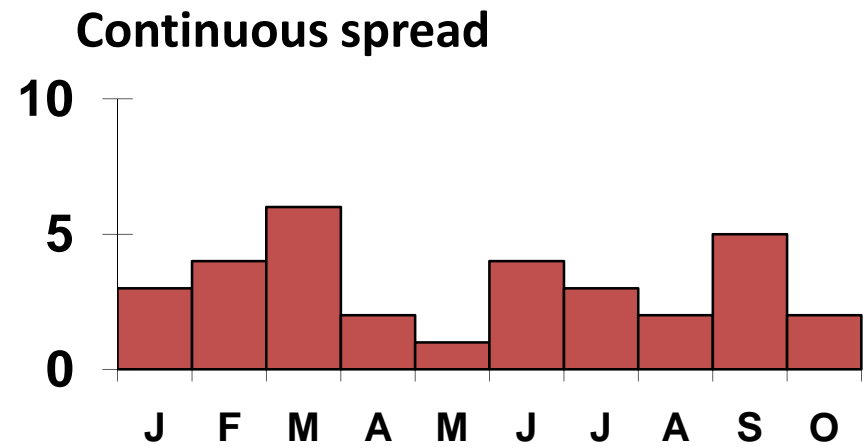
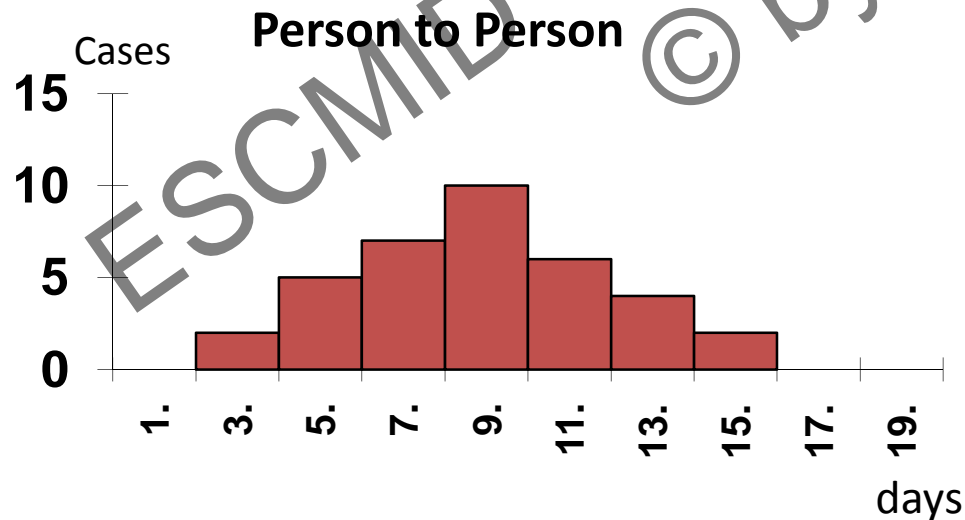


Significant increase?
- same diagnostic measures?
- same case definition?

Information from the epidemic curve



Type of transmission



Line-Listing

Creation of a list with all cases and potential risk factors

e.g.

- Age
- Underlying disease
- Day of admission
- Day of infection/colonization
- Expositions before occurrence of infection/colonization
 - Invasive measures (endoscopy, surgical procedures, sonography)
 - Therapy (specific drugs)
 - Exposition to staff (HCW A or B), rooms (operating room A or B)

Line listing

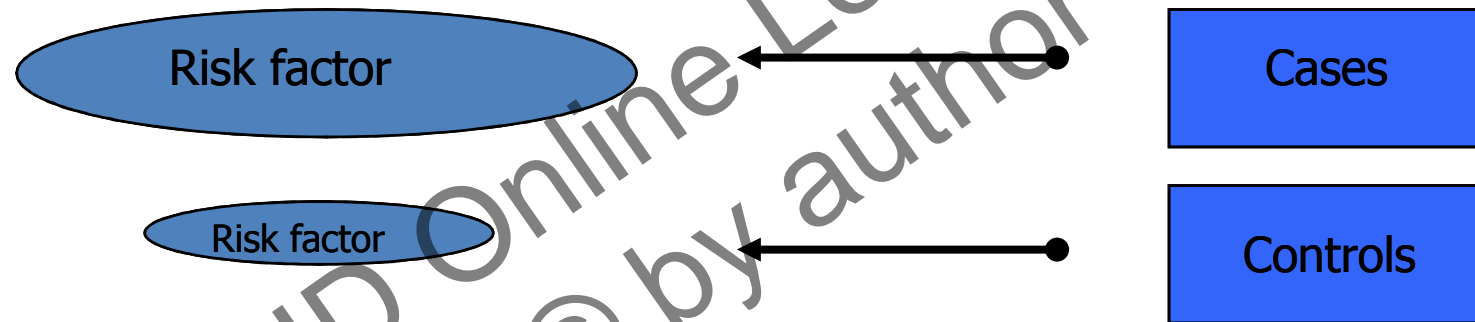
Case	Notifi- cation date	Ad- mission date	First symp- toms	Diag- nosis	Nausea	Fever	Ic- terus	HAV IgM	ward	...
MK	12.3.	3.1.	8.3.	Hep.A	+	+	-	+	4a	
SE	15.3.	14.1.	15.3.	Hep.A	+	+	+	+	7	
JG	16.3.							
SG								

Hypotheses about sources of infection and transmission routes

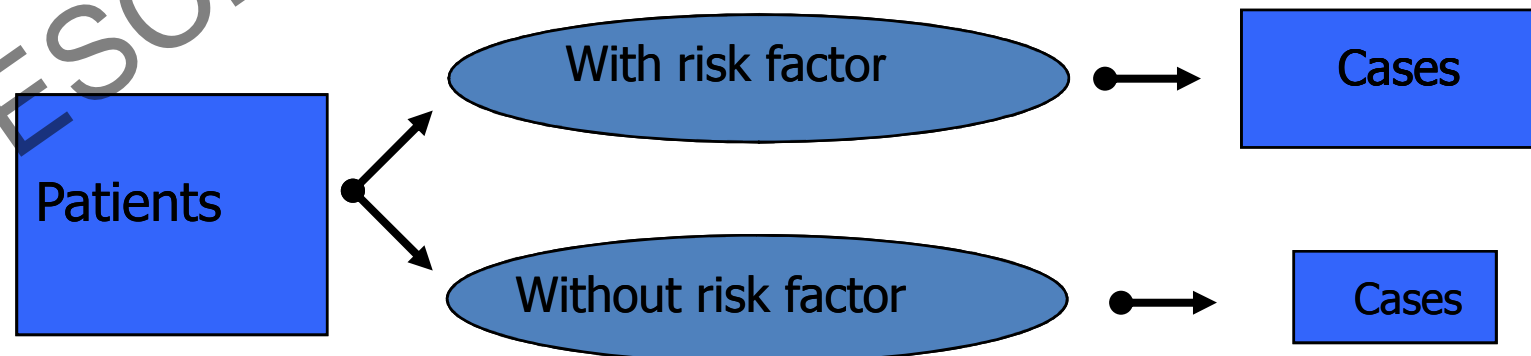
- Based on: –
 - Epidemic curve
 - Line-Listing
 - Literature
 - Other sources
(ideas of the staff and other people involved)
- Concentrating on:
 - Reservoir of the pathogen
 - Route of transmission

Studying the hypothesis

Case control study



Cohort study



Example for a case control study

OPEN ACCESS Freely available online

 PLOS ONE

MRSA Transmission on a Neonatal Intensive Care Unit: Epidemiological and Genome-Based Phylogenetic Analyses

Ulrich Nübel^{1*}, Matthias Nachtnebel^{2,3,4}, Gerhard Falkenhorst², Justus Benzler², Jochen Hecht^{5,6}, Michael Kube⁵, Felix Bröcker⁵, Karin Moelling^{5,7}, Christoph Bühner⁸, Petra Gastmeier⁹, Brar Piening⁹, Michael Behnke⁹, Manuel Dehnert², Franziska Layer¹, Wolfgang Witte¹, Tim Eckmanns²

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Nübel et al. PLoS One 2013;8(1):e54898. doi:

MRSA outbreak in a neonatal department

- Whole genome sequencing to trace MRSA spread
- Case control study to identify risk factors for MRSA transmission

Case = patient in the NICU in whom colonisation or infection with MRSA spa type 032 (ST22) was detected between February 8th and August 31st 2010

Controls = MRSA negative NICU patients matched for birth weight (+/-100 g), two controls if possible

MRSA outbreak in a neonatal department

- 32 neonates had tested positive for MRSA, spa type t032
- 4 % of all new admissions (32/745)
- Five neonates had an infection
- 23 infants fulfilled the case definition, 37 controls
- Staff screening identified two HCW as being colonized with MRSA spa type t032

Table 1. Characteristics of the cases and controls matched for weight at birth and age during exposure time.

	Cases	Controls	Level of significance (p-value) [#]
Weight at birth (median and range)	1165 g (606–3800 g)	1256 g [†] (625–3740 g)	0.91
MRSA infection [†]	22% (5/23)	n/a	
Duration until MRSA positive (median and range)	8 days* (2–91 days)	n/a	
Male gender	52% (12/23)	41% (15/37)	0.38
Birth by caesarean section	83% (19/23)	81% (29/36)	0.84
Multiples	52% (12/23)	35% (13/37)	0.15
Gestational age (median and range)	29 weeks (23–42)	32 weeks [†] (24–41)	0.43
Born on-site	91% (21/23)	97% (32/33)	0.35
Length of stay (median and range)	47 days (6–103)	38 days [†] (7–116)	0.61

*from birth or last negative swab to first positive.

[#]Kruskal Wallis, Chi2.

[†]as opposed to colonisation.

[‡]In pairs with two controls, the average value of the controls was used for the calculation.

doi:10.1371/journal.pone.0054898.t001

Nübel et al. PLoS One 2013;8(1):e54898. doi:

Table 2. Risk factor analysis in univariable logistic regression.

Variable	Odds-Ratio and 95% CI	p-value
Additional unknown MRSA-positive infant on ward	2.5 (1.26–7.99)	0.003
Contact with HCW A	9.3 (1.24–Inf)	0.03
Increase of infant-to-staff ratio by 1 unit	2.8 (1.06–9.34)	0.04
Additional unknown MRSA-positive infant in room	4.2 (0.98–197)	0.06
Peripheral venous line	0.1 (0–1.11)	0.07
Episodes of bradycardia	4.7 (0.89–47.5)	0.07
Blood transfusion	6.9 (0.72–335)	0.12
Number of X-ray treatments	0.6 (0.27–1.15)	0.16
Gastric tube	5.6 (0.62–276)	0.18
Per known MRSA-positive infant on ward	1.0 (0.97–1.13)	0.24
Number of sonographies	1.2 (0.75–1.86)	0.54
Mechanical ventilation with intubation	0.9 (0.69–1.21)	0.60
Parenteral nutrition	0.4 (0.04–3.91)	0.63
Antibiotic therapy during exposure	0.7 (0.13–3.31)	0.82
Sum of oral medications	1.1 (0.60–2.11)	0.86
Central venous line	1.4 (0.02–118)	1
Skin-to-skin ('kangaroo') care	0.8 (0.18–3.47)	1

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Calculation of the number of outbreaks in neonatal ICUs in Germany

- Based on the NEO KISS database
- Period from 2006-2011
- Use of different time periods to define a cluster of HCAI: 2 weeks, 4 weeks, 2 months for the most frequent pathogens (without CNS)
- Data from 44 000 patients from 230 NICUs included

Schwab/Geffers, NEO-KISS database

Calculation of the total number of outbreaks in neonatal ICUs in Germany

	2 weeks cluster	4 weeks cluster	2 months cluster
S.aureus	57	83	92
Enterokokken	37	52	66
Enterobacter	30	47	61
E.coli	27	42	61
Klebsiellen	28	45	60
P.aeruginosa	5	9	14
Serratia	11	14	18
Candida	11	15	23
TOTAL	206	307	395
Per year	34 outbreaks	52 outbreaks	66 outbreaks
Per neonatal ICU	Every 7 years	Every 5 years	Every 4 years

Schwab/Geffers, NEO-KISS database