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BACTERIAL INTERVENTIONS TO INCREASE BLOOD SAFETY

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on behalf of

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Klebsiella oxytoca

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Overview

- Risk of bacterial transmission
- Sources of contamination
- Organisms implicated
- Interventions

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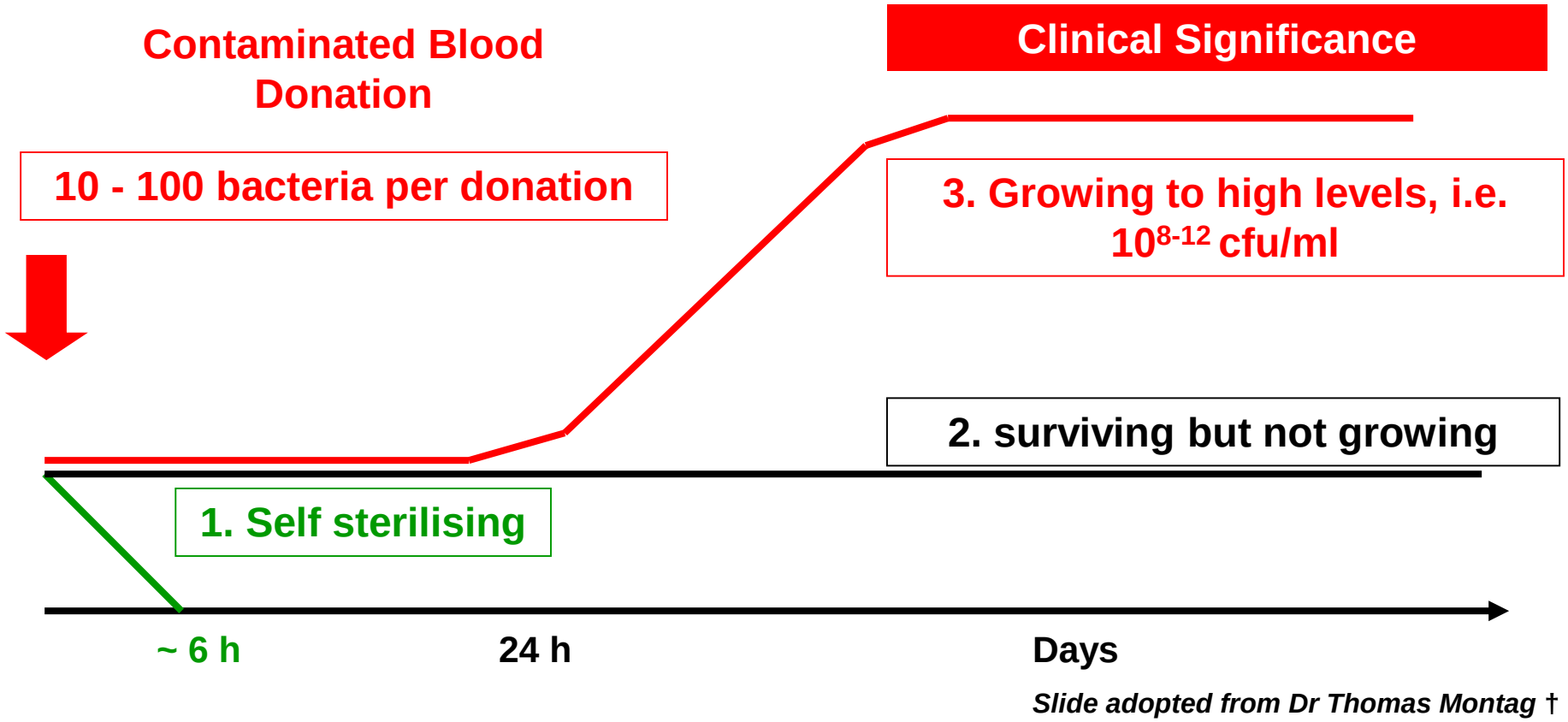
Bacteria in Blood Components



Slide adopted from Dr Thomas Montag †

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Bacterial Mortality Worldwide

USA	2005-2015	38 deaths	(FDA)
France	1994-2015	36 deaths	(Haemovigilance)
Germany	1997-2014	14 deaths	(Haemovigilance)
U.K.	1994	3 deaths	(Pre-SHOT)
U.K.	1996-2016	11 deaths	(SHOT)

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SHOT Reports (1996 – 2016)

- 44 cases
- 11 fatalities (9 platelets, 2 red cells)
- 37/44 (84%) involved PCs
- Bacteria major cause TTIs and death

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Platelet Components

- Room temperature storage
- Optimal for platelet viability and function
- Facilitates bacterial proliferation
- Immunocompromised

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Platelet Components Are The Greatest Risk!

- **USA: (FDA) 2005 – 2015 platelet components comprised 87% (33/38) bacterial fatalities**
- **UK: (SHOT) 1996 – 2016 platelet components comprised 84% (37/44) cases**

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Contamination of Blood Units

- Collection stage
- During processing

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Collection

- **Asymptomatic bacteraemia in donor:**

  (a) incubation or recovery period from bacterial illness

  (b) chronic low grade infection

  (c) transient bacteraemia

- **Inadequate disinfection of venepuncture site**

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Organisms Implicated in Clinically Apparent Bacterial Transfusion Reactions

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Organisms Implicated in Bacterial Transmissions from NHSBT Platelet Components: 1995 - 2016

	Organism	Frequency	Potential Source	Patient outcome
Gram Negative	*Klebsiella pneumoniae*	2	Gut	Death (3)
	Escherichia coli	2	Gut	Death (1)
	Enterobacter aerogenes	1	Gut	Death (1)
	Morganella morganii	1	Gut/Environment	Morbidity (1)
Gram Positive	*Staphylococcus* spp.	16	Skin	Death (2) Morbidity (14)
	Bacillus cereus	4	Environment	Death (1)
	Streptococcus spp.	7	Nose and Throat/Gut	Morbidity (7)

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Organisms Implicated in Bacterial Transmissions from NHSBT Red Cell Components: 1995 - 2016

	Organism	Frequency	Potential Source	Patient Outcome
Gram Negative	*Pseudomonas putida*	2	Environment	Death (1)
	Yersinia enterocolitica	1	Gut	Death (1)
	Enterobacter cloacae	1	Gut	Morbidity (1)
	Serratia liquifaciens	1	Gut	Morbidity (1)
Gram Positive	*Staphylococcus* sp.	1	Skin	Morbidity (1)

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NHSBT Bacterial Transmission Prior to Interventions

- **Platelet Components 22 cases (5 death)**
- **Red Cells 3 cases (1 death)**

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National Monitoring Study (1999 - 2000)

Platelet Components:

Pooled:	1 in 233 (0.43%)
Apheresis:	1 in 257 (0.37%)
Total:	1 in 242 (0.41%)
Red Cell Components:	1 in 1235 (0.06%)

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Strategy

- Improved donor arm disinfection
- Diversion
- Bacterial screening/Pathogen inactivation

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Improved Donor Arm Disinfection

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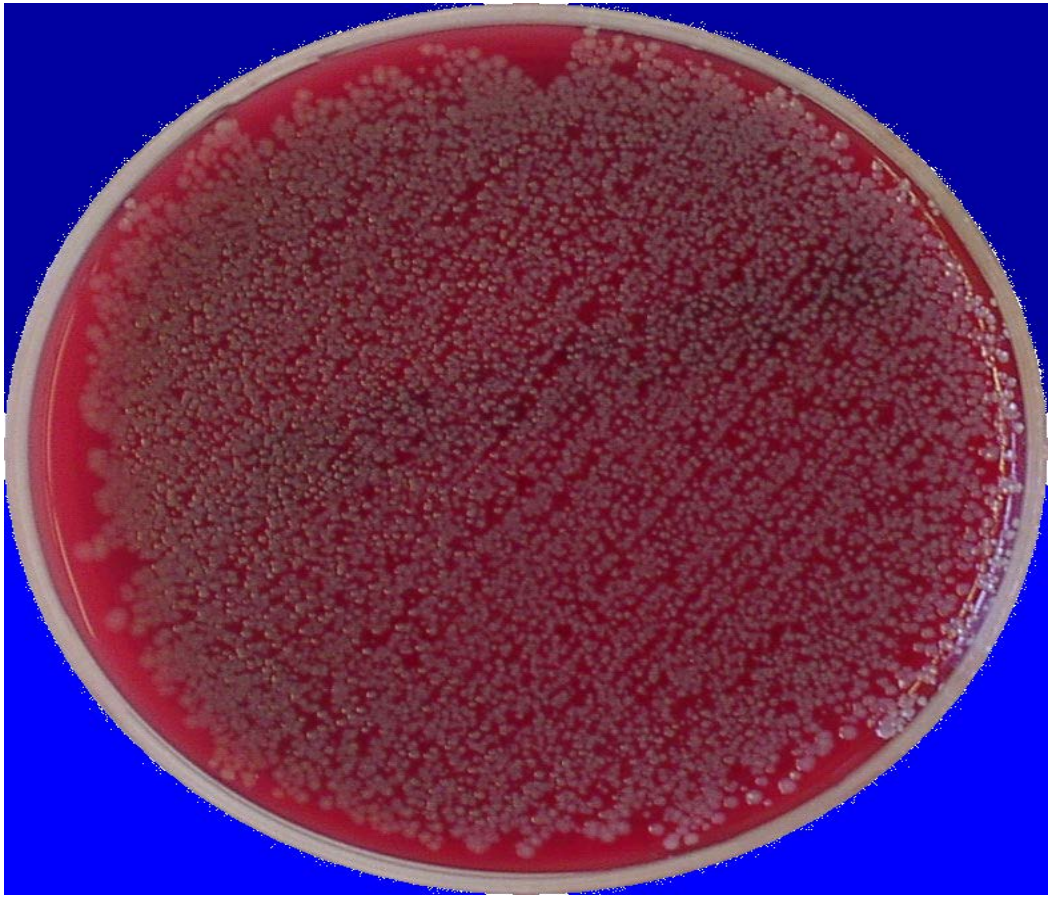
Donor Arm Swab Pre-Disinfection



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Bacterial Contamination at Venepuncture Site

NBL studies indicate:

- **50% donors have 10^5 organisms/cm^2 (swab cup method)**
- **17% donors $\geq$ 5000 cfu/plate (direct swabbing plating technique)**

McDonald C.P. *et al*., Evaluation of donor arm disinfection techniques, Vox Sanguinis (2001), 80:135-141

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Potential Influential Factors of Bacterial Contamination at the Venepuncture Site

- Age
- Gender
- Occupation
- Donor appearance
- Amount of hair on site

NB: vigorous arm disinfection needs to be applied to all donors

McDonald C.P. *et al*., The validation and monitoring of pre-venepuncture arm cleansing at NLBTC. Transfus Med 1994; 4:56

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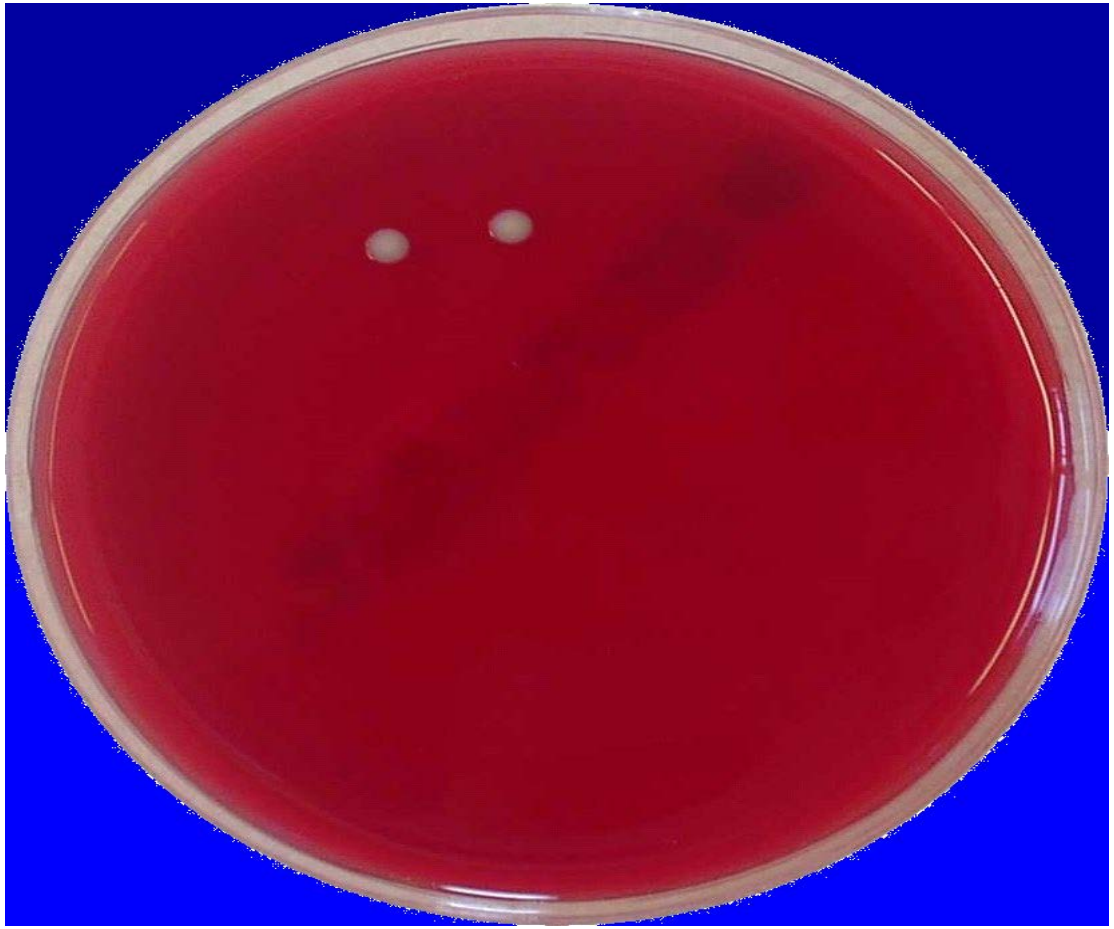
Donor Arm Post-Disinfection



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Critical Factors for Donor Arm Disinfection

- Disinfectant or disinfectants utilised
- Type of applicator utilised: sponge, swab, wipe, gauze
- Method of application:
  - One or two stage process
  - Time of application
  - Time of drying of the disinfectant
  - Mode of application
- Quantity of disinfectant dispensed

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Effectiveness of the Intervention of Improved Donor Arm Disinfection

- Improved donor arm disinfection reduced bacterial contamination in apheresis platelet components in the order of 57%
- Reduction in clinically apparent cases by 65%

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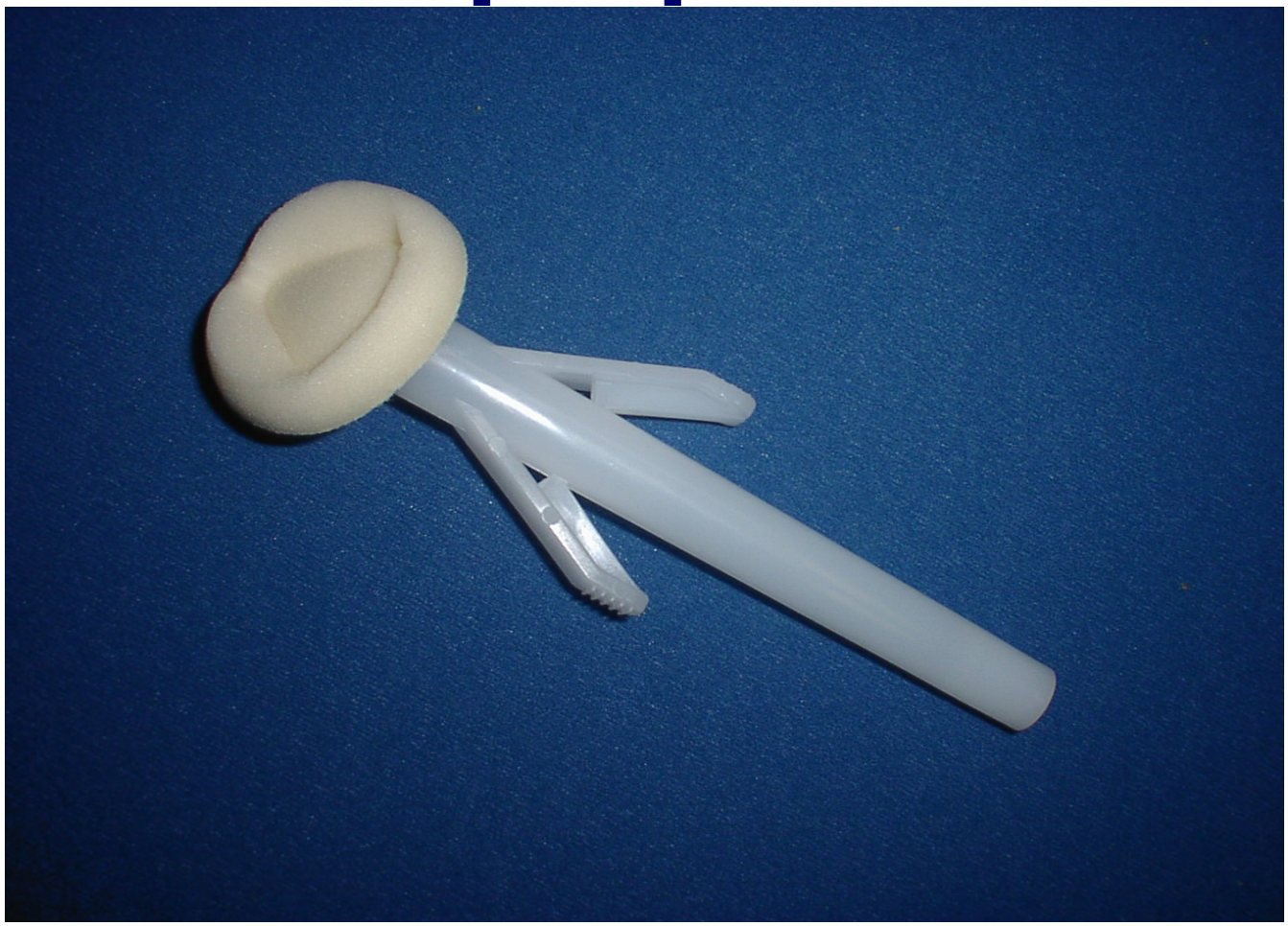
Chloraprep® 'Wand'



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Use of the Chloraprep®

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Diversion

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Comparison of Diversion Trial Studies

- **National Bacteriology Laboratory (NHSBT)** — **Reduction 50%**
- **France (Vassout-Bruneau et al AABB 1999)** — **Reduction 72%**
- **Netherlands (Olthuis et al, Vox.Sang.1996,70,2,113)** — **Reduction 82%**

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Effectiveness of the Intervention of Diversion

- Diversion reduced bacterial contamination in pooled platelet components in the order of 66%
- Reduction in clinically apparent cases by 76%

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Interventions Introduced

- **Improved Donor Arm Disinfection – implemented nationally 2007**
- **Diversion – implemented nationally 2003**
- **In combination 77% reduction in contamination**

McDonald, C.P. *et al.*, Relative Values of the Interventions of Diversion and Improved Donor-Arm Disinfection to Reduce the Bacterial Risk from Blood Transfusion: Vox Sanguinis (2004), 86:178-182

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Two interventions implemented?

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Post Implementation Improved Donor Arm Disinfection and Diversion (2006 – 2010)

- 7 contamination incidents in PC
- 10 patients affected
- 3 deaths
- 5 near misses

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Screening

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BacT/ALERT System

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BacT/ALERT Sampling

BacT/ALERT System

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BacT/ALERT Culture Bottles

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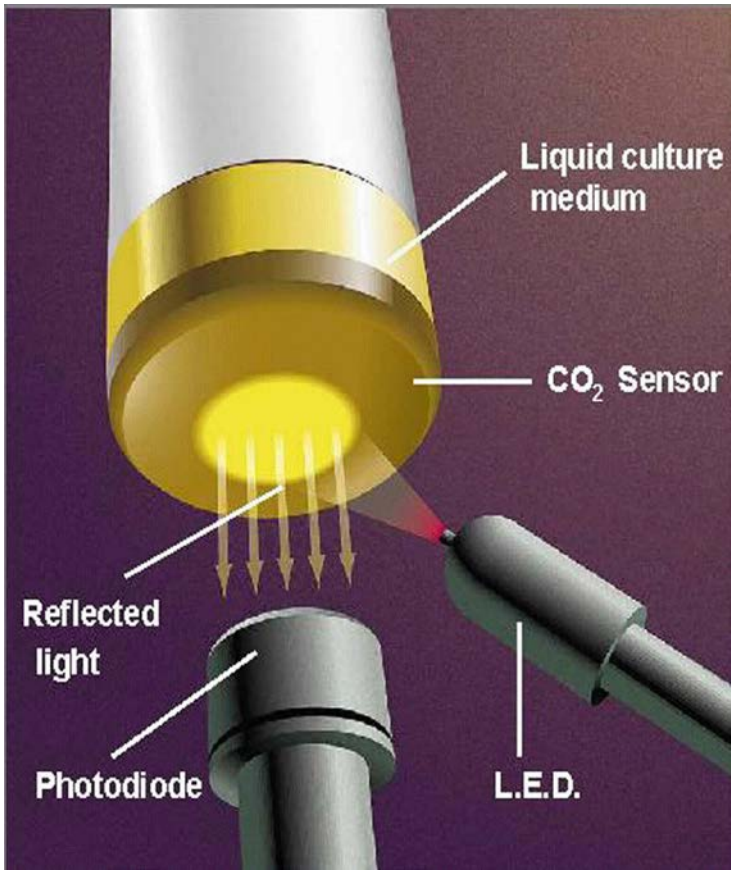
Reflectance Measurement

- LED illuminates sensor
- Continuous monitoring: bottles are read every 10 minutes (144 times/day)
- Photodiode collects reflected light
- Signal transmitted to computer
- “Reflectivity Units” plotted over time



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NHSBT Test Protocol
(1 test, Extension Shelf Life to 7 Days)

1. Platelet components held for ≥ 36h – 48h after collection
2. Platelet components sampled and tested
3. Held for 6h (12h within building)
4. Released with a 7 day shelf life
5. Monitored for 7 days
6. Positives recalled

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Bacterial Screening Sites:

- Colindale
- Filton
- Manchester
- Sheffield
- Newcastle

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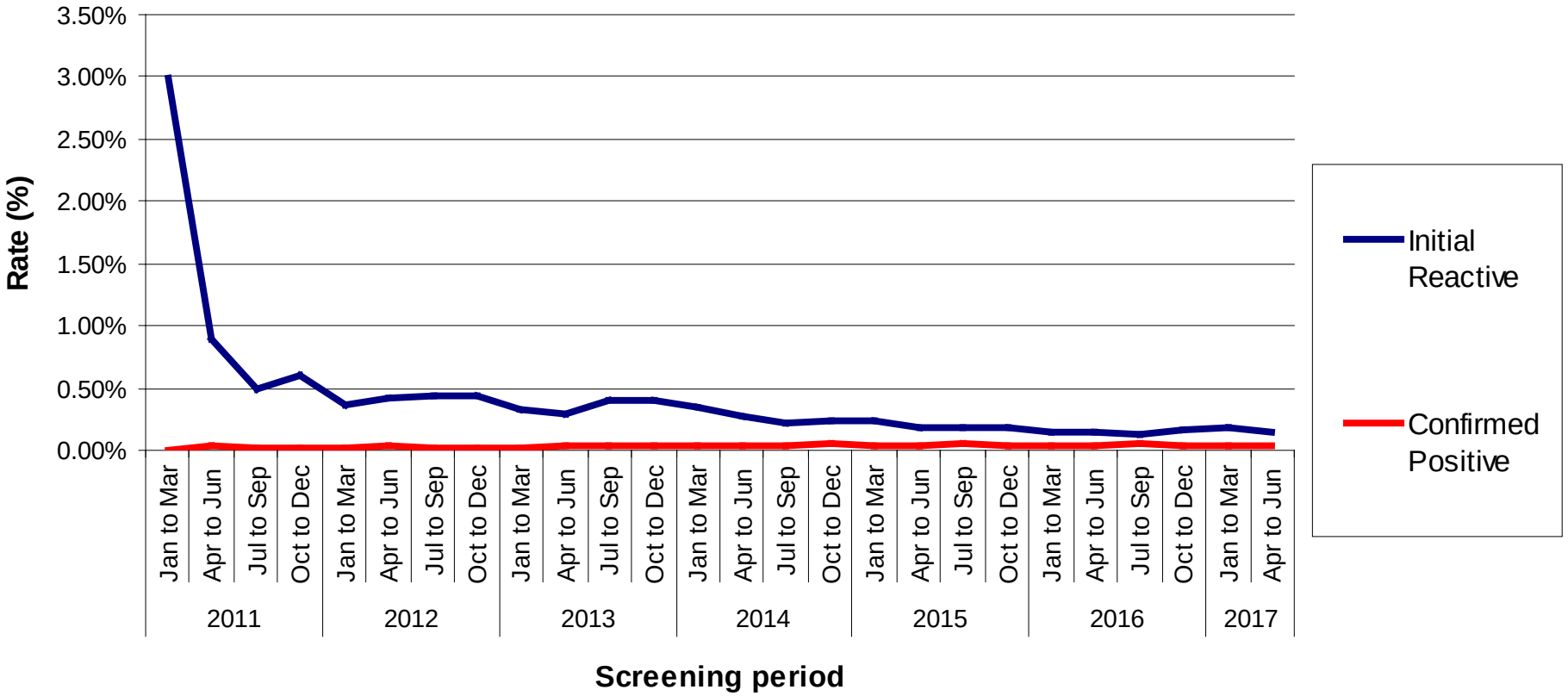
Quarterly Bacterial Screening Rates (February 2011 - June 2017)



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Initial Reactive and Confirmed Positive Rates (Cumulative February 2011 – June 2017)

	Total Screened	Initial Reactive Rate	Confirmed Positive Rate
Apheresis*	1,251,339	0.34%	0.02%
Pooled*	493,193	0.24%	0.07%
Total	1,744,532	0.31%	0.04%

*Apheresis platelets screened from Feb 2011
*Pooled platelets screened from May 2011

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Confirmed Positives (February 2011 – June 2017)

- 618 confirmed
- 595 Gram positives
- 23 Gram negatives

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Confirmed Positive Gram Positive 'Pathogenic' Organisms (Feb 2011 – Jun 2017)

Organisms	n	IR Detection Time Range (h)	Total Contaminated Components
Streptococcus dysgalactiae (Group G/C)	23	2-19	26
Staphylococcus aureus	16	2-21	17
Streptococcus pneumoniae	12	9-13	16
Streptococcus agalactiae (Group B)	5	6-16	4
Listeria monocytogenes	4	14-20	5
Bacillus cereus	2	4-14	2

Total organisms: 62 **Total components: 70**

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Confirmed Positive Gram Negative 'Pathogenic' Organisms (Feb 2011- Jun 2017)

Organisms	n	Detection Time Range (h)	Total Contaminated Components
Escherichia coli	8	3-14	17
Serratia marcescens	3	4-13	5
Klebsiella oxytoca	3	3-9	4
Klebsiella pneumoniae	2	4-11	3
Pseudomonas aeruginosa	1	15	1
Campylobacter lari	1	32	1

Total organisms: 18

Total components: 31

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NHSBT Screening (February 2011 to June 2017)

- **1 transmission in >1.7million PC screened (*S.aureus*)**
- **4 near misses (3 *S. aureus* and 1 *S. marcescens*)**
- **1 CP in 6015 TE platelets screened *(S. pneumoniae)***
- **False negative rate 1 in 349,000 (0.0003%)**

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Implementation of Bacterial Screening by NHSBT has been an extremely successful risk reduction intervention!

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Conclusion

Introduced:

- Improved Donor Arm Disinfection
- Diversion
- Screening

Future Consideration:

- Pathogen Inactivation

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The Transmission of Bacteria by Transfusion Remains a Significant Problem in Transfusion Medicine

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Thank You

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