More than just teddy bears: Unconventional transmission agents in the operating room

A. Hardy^{a,*}, V. Sabatier^a, O. Rosello^a, B. Salauze^b, F. Barbut^c, R. Vialle^{a,d}

^a Department of Paediatric Orthopaedics, Pierre and Marie-Curie University Paris 6, Armand-Trousseau Hospital, 26, avenue du Dr Arnold-Netter, 75571 Paris cedex 12, France

^b Interventional Unit for Hospital Hygiene, Pierre and Marie-Curie University Paris 6, Armand-Trousseau Hospital, 26, avenue du Dr Arnold-Netter, 75571 Paris cedex 12, France

^c Microbiology Department, Pierre and Marie-Curie University Paris 6, Saint-Antoine hospital, rue du Faubourg-Saint-Antoine, 75011 Paris, France

^d Department for Innovative Therapies in Musculoskeletal Diseases, The MAMUTH Hospital-University, Armand-Trousseau Hospital, 26, avenue du Dr Arnold-Netter, 75571 Paris cedex 12, France

ABSTRACT

Introduction: Surgical site infection (SSI) following orthopedic surgery can have a substantial impact on patients and families. The rate remains high, ranging from 0.5% to 8.5% in pediatric spine surgery. It is common to allow children to bring a teddy bear (or similar toy) to the surgical ward to help reduce the stress of surgery. We hypothesize that despite their known benefits for children, teddies would increase the bacterial load in the surgical room.

Methods: A blinded descriptive study was conducted from June 2015 to September 2016. The study included children entering the hospital through the emergency ward for a traumatic cause requiring surgery. Patients admitted for infectious problems and those who had been hospitalized less than 6 months before the inclusion date were excluded. A picture of the teddy was taken and stored in a blind fashion. The AFNOR (Association française de normalisation) standardized rules for bacteriological surface control and the ISO/DIS 14698 protocol were strictly followed. Two independent observers performed blind bacteriologic analyses of the teddy bears with bacteria identification and colony counts. Photos of the teddy bears were then analyzed by two blinded, independent observers: one doctor and one parent from outside the hospital. Cleanliness and fluffiness of the toy was evaluated using a numeric scale.

Results: Bacteria were identified on 100% of the 53 teddies included. The mean number of bacteria was 182.5 ± 49.8 CFU/25 cm². Eight teddies (15.1%) tested positive for potential pathogenic bacteria (two *staphylococcus aureus*, one *acinetobacter ursingii*, four *acinetobacter baumannii*, one *pseudomonas stutzeri*). Three teddies (5.7%) tested positive for fungi. The median cleanliness score was 2 (interquartile range (IQR) = 1) if rated by the doctor and 2 (IQR = 1) if rated by the parent. No statistical difference was found between these two values in the global teddy bear population. We found no any statistical link between the number of CFUs and the cleanliness scores given by the doctor. The median fluffiness score given by the parent was 2 (IQR = 1). Looking at the correlative CFUs, we found a statistically significant difference between each stage of fluffiness with a higher stage showing higher CFU ($P < 0.0001$).

Conclusion: Despite their documented benefits for the child, teddy bears are not appropriate in the surgical room.

Keywords:
Teddy bear
Infection
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1. Introduction

Surgical site infection (SSI) following orthopedic surgery has a substantial medical, social, and financial impact on patients and families [1,2]. In pediatric departments, orthopedic surgeries may

be performed on vulnerable patients. For patients suffering from cerebral palsy or other neuromuscular conditions, the occurrence of SSI can be devastating, as these infections are difficult to treat and often require surgical debridement, long-term antibiotics, and hardware removal [3,4]. Therefore, it is important to clarify the risk factors for SSI development. Preoperative, intraoperative, and postoperative factors contribute to the overall bacterial load to which surgical patients are exposed. Some of these factors are modifiable and improve with aggressive surgical sterilization

* Corresponding author. 27, rue Morand, 75011 Paris, France.
E-mail address: A.Hardy^a-Alexandre.hardy@me.com (A. Hardy).

practices (e.g., surgeon hand preparation, antibiotic prophylaxis), whereas others are unavoidable (e.g., patient factors such as immunosuppression, neuromuscular conditions, diabetes) [5–7].

Because much of the success in SSI prevention depends on factors in the operating room, most providers believe that the majority of SSIs result from exposing an open wound to bacteria during surgery. Providers have developed preventive measures to ensure sterility and minimize infection risks. Massive efforts to implement these protocols have decreased—but not completely eliminated—occurrence of SSIs. For example, despite the use of multiple measures to reduce overall incidence of SSI after pediatric spine surgery, the rate remains high, ranging from 0.5% to 8.5%, depending on the population studied [8,9]. Other intraoperative factors that contribute to the overall bacterial load to which the patient is exposed include both the sterile items already in the operating room at the beginning of a procedure (e.g., gowns, drapes, implants, etc.) and nonsterile items that are brought into the operating room by caregivers and the patient.

As a nonpharmacological intervention, it is common to allow children to bring a teddy bear (or similar toy) to the surgical ward to help reduce the stress of surgery [10]. After surgery, access to teddy bears may be part of distraction techniques that help reduce postoperative pain and anxiety [11–13]. But is it appropriate to admit the child's best friend in a surgical room? We hypothesize that nonsterile items brought into the operating room to decrease children's anxiety (e.g., stuffed animals, toys, etc.) are a reservoir of bacteria that contribute to the overall bacterial load to which surgical wounds are exposed, thus increasing the risk of SSI. The goal of this study was to evaluate the level of colonization in these unconventional transmission agents admitted to the operating room and to look for specific potential pathogens among the bacteria identified. We also attempted to evaluate the effectiveness of a visual evaluation of the toy's cleanliness and fluffiness by either a doctor or a parent to predict the colonization level. We hypothesized that, despite their known benefits for children, teddies would increase the bacterial load in the surgical room.

2. Material and methods

From June 2015 to September 2016, this study included children entering the hospital through the emergency ward for a traumatic cause requiring surgery. Patients admitted for infectious problems and those who had been hospitalized less than 6 months before the inclusion date were excluded. This way, we attempted to ensure a homogenous cohort and focused on possible bacterial contamination of the teddy due to outside germs.

2.1. Bacteriological screening

When children had multiple teddies, we tested only their favorite one. We collected written consent from the parents (and possibly the child). Then we took a picture of the teddy and stored the photo in a blind fashion. The bacteriological screening and tests were performed during the interval between admission to the emergency room and access to the operating room to prevent any intrahospital contamination. AFNOR (Association française de normalisation) standardized rules for bacteriological surface control and the ISO/DIS 14698 protocol were strictly followed [14]. Both recommend applying pressure on the measurement area of 500 ± 50 g for 10 second on a 25-cm surface. A standardized applicator was used to ensure reproducible measurements, with the same amount of pressure and contact time between the plate and the teddy (Count-Tact Applicator[®], Biomerieux, 376 chemin de l'Orme, 69280 Marcy l'Étoile, France). As recommended, we used a 25-cm² trypticase soy agar. Measurements were taken at the center of the

teddy bear's belly. The three examiners (AH, VS, and OR) wore surgical gloves during sample collection to prevent contamination. The samples collected were incubated for 24 hour at 37 °C.

2.2. Analysis

Two independent observers performed blind bacteriologic analyses of the teddy bears. For each sample, the analysis identified individual bacteria and counted colonies, in addition to specifying pathogenic versus saprophytic bacteria. Photos of the teddy bears were then analyzed by two blinded, independent observers: one doctor and one parent from outside the hospital. They were asked to rate the appearance of each teddy bear subjectively. They first evaluated the cleanliness of the toy using a numeric scale from 1 to 5: 5 was the dirtiest possible teddy and 1 described an apparently immaculate teddy. Next, only the parent evaluated the fluffiness of the teddy, using the scale introduced by Davies et al. [15]: 1 = plastic, 2 = minimal fluffiness, 3 = moderate fluffiness, and 4 = very fluffy.

Data were collected in a computerized database and analyzed with SPSS V22.0 software (SPSS Inc., Chicago, IL, USA). To assess the correlation between the cleanliness/fluffiness ratings given by the observers and the colony-forming unit (CFU) count, a Kruskal-Wallis test was used. A *P*-value for *t*-tests was considered significant if less than 0.05.

3. Results

This study included the teddy bears of 53 children. The population consisted of 30 girls and 23 boys, aged 0–14 years (mean, 4.3 years). Bacteria were identified on 100% of the teddies. The mean number of bacteria was 182.5 ± 49.8 CFU/25 cm². The mean number of different isolates was 3.7/teddy (from two to six different bacteria). Fifty-two teddies (98.1%) tested positive for commensal flora bacteria. Coagulase-negative staphylococcus was identified on 49 teddies (92.5%), and 38 teddies (73.6%) tested positive for saprophytic bacteria. Eight teddies (15.1%) tested positive for potential pathogenic bacteria (two *staphylococcus aureus*, one *acinetobacter ursingii*, four *acinetobacter baumannii*, one *pseudomonas stutzeri*). Three teddies (5.7%) tested positive for fungi. All isolated bacteria are summarized in Table 1.

Photos of all the teddies are included in Fig. 1. The median cleanliness score was 2 (interquartile range (IQR) = 1) if rated by the doctor and 2 (IQR = 1) if rated by the parent. No statistical difference was found between these two values in the overall teddy bear population. We found no statistical link between the number of CFUs and the cleanliness scores given by the doctor.

The median (interquartile range) fluffiness score given by the parent was 2 (IQR = 1). Only one teddy was made of plastic and therefore ranked 1. Twenty-six teddies were ranked 2, 20 were ranked 3, and five ranked 4. Looking at the correlative CFUs, we found a statistically significant difference between each stage of fluffiness with the higher stage showing increased CFU (*P* < 0.0001). The details of the different groups are reported in Table 2.

4. Discussion

In a pediatric surgery department, we are privileged to have the presence of transitional objects close to our young patients. Stuffed animals, rag dolls, and teddy bears are abundantly present and harmoniously integrated into the team's daily work. Following Winnicott's studies [16] and according to the New York University Psychoanalytical Institute, "the transitional object may be conceived of in three ways: as typifying a phase in a child's development; as a defense against separation anxiety; and, lastly,

Table 1

All bacteria isolated on the teddy bears.

Sample date	Commensal flora	Saprophytic germs	Potential pathogens
6/11/2015	<i>Micrococcus luteus</i> , <i>Staph. Hominis</i> , <i>Staph. Warneri</i> , <i>Moraxella</i> sp.	<i>Roseomonas mucosa</i> , <i>Kocuria Kristinae</i>	
6/11/2015	<i>Staph. Warneri</i> , <i>Micrococcus luteus</i>	<i>Paenibacillus pabuli</i>	
6/11/2015	<i>Micrococcus luteus</i> , <i>Staph. Hominis</i> , <i>Staph. capitis</i>	<i>Kocuria palustris</i>	
6/12/2015	<i>Micrococcus luteus</i> , <i>Staph. Epi</i> , <i>Staph. Hominis</i>	<i>Rhizobium radiobacter</i>	
6/18/2015	<i>Micrococcus luteus</i> , <i>Staphylococcus hominis</i>	<i>Empedobacter brevis</i> , <i>Bacillus cereus</i>	
6/18/2015	<i>Staph. Saprophyticus</i> , <i>Micrococcus luteus</i>		
6/18/2015	<i>Staph. Haemolyticus</i> , <i>Staph. Hominis</i> , <i>Micrococcus luteus</i> , <i>Staph. Epi</i>		
6/24/2015	<i>Micrococcus luteus</i> , <i>Staph. Hominis</i> , <i>Staph. Epi</i>		
7/6/2015	<i>Micrococcus luteus</i> , <i>Staph. hominis</i> , <i>Staph. Saprophyticus</i> , <i>Staph. Warneri</i>		
7/5/2015	<i>Staph. epi</i> , <i>Staph. Warneri</i>		
7/5/2015	<i>Staph. Epi</i> , <i>Micrococcus luteus</i> , <i>Staph. Warneri</i>	<i>Paracoccus yeii</i>	
7/5/2015	<i>Staph. Warneri</i> , <i>Staph. hominis</i>	<i>Kocuria rosea</i>	
7/13/2015	<i>Staph. Hominis</i> , <i>Micrococcus luteus</i> .		
7/13/2015	<i>Micrococcus luteus</i> , <i>Staph. Hominis</i> , <i>Staph. capitis</i>	<i>Lysobacter</i> sp.	
7/14/2015	<i>Staphylococcus epidermidis</i> , <i>Micrococcus luteus</i>		<i>Staphylococcus aureus</i>
7/15/2015	<i>Staphylococcus epidermidis</i> , <i>Micrococcus luteus</i>	<i>Bacillus megaterium</i>	<i>Staphylococcus aureus</i>
7/18/2015	<i>Staph. hominis</i> , <i>Staph. warneri</i> , <i>Micrococcus luteus</i>	<i>Arthrobacter</i> sp., <i>Microbacterium</i> sp.	
7/19/2015	<i>Staph. Hominis</i> , <i>Micrococcus luteus</i> ,	<i>Bacillus</i> sp.	
7/19/2015	<i>Staph. Hominis</i> , <i>Staph. Xylosus</i> , <i>Micrococcus luteus</i> , <i>Staph. haemolyticus</i>	<i>Acinetobacter ursingii</i>	<i>Acinetobacter ursingii</i>
7/22/2015	<i>Micrococcus luteus</i> , <i>Staph. Epi</i> , <i>Staph. hominis</i>	<i>Bacillus cereus</i>	
7/22/2015	<i>Staph. Warneri</i> , <i>Staph. hominis</i>	<i>Bacillus cereus</i>	
7/22/2015	<i>Staph. Simulans</i> , <i>Staph. hominis</i> , <i>Micrococcus luteus</i> .	<i>Bacillus simplex</i>	
7/22/2015	<i>Micrococcus luteus</i> , <i>Staph. hominis</i> , <i>Staph. warneri</i>	<i>Bacillus simplex</i> , <i>Curtobacterium</i> sp., <i>Lactobacillus sakei</i>	
8/4/2015	<i>Staph. Epi</i> , <i>Micrococcus luteus</i> , <i>Micrococcus</i> sp.	<i>Bacillus</i> sp.	
8/12/2015	<i>Micrococcus luteus</i> .	<i>Bacillus</i> sp.	
8/13/2015	<i>Staph. hominis</i> , <i>staph. Cohnii</i> , <i>staph. epi</i> .	<i>Kocuria rhizophila</i> , <i>Acinetobacter</i> sp.	
8/25/2015	<i>Staphylococcus epidermidis</i>	<i>Kocuria rhizophila</i> , <i>Bacillus cereus</i> , <i>Microbacterium</i> sp.	
8/25/2015	<i>Staph. epidermidis</i> , <i>Micrococcus luteus</i>		
8/25/2015		<i>Bacillus cereus</i> , <i>Kytococcus sedentarius</i> , <i>Acinetobacter lwoffii</i> ,	
8/25/2015	<i>Micrococcus luteus</i> , <i>Staphylococcus haemolyticus</i>	<i>Bacillus flexus</i> , <i>Acinetobacter</i> sp.	
8/26/2015	<i>Micrococcus luteus</i> , <i>Staphylococcus haemolyticus</i> , <i>Corynebacterium</i> sp.	<i>Kocuria palustris</i>	
8/28/2015	<i>Staph. epidermidis</i> , <i>Staph. haemolyticus</i>		
9/1/2015	<i>Staph. Epidermidis</i> , <i>Micrococcus luteus</i>	<i>Bacillus cereus</i> .	<i>Acinetobacter baumannii</i>
9/1/2015	<i>Staph. epidermidis</i> , <i>Micrococcus luteus</i>	<i>Bacillus cereus</i> , <i>Pantoea</i> sp.	
9/3/2015	<i>Staphylococcus hominis</i> , <i>Micrococcus luteus</i>	<i>Bacillus cereus</i> , <i>Kocuria rhizophila</i>	
9/9/2015	<i>Micrococcus luteus</i> , <i>Staph. Epidermidis</i>	<i>Acinetobacter johnsonii</i> , <i>Aerococcus viridans</i>	
9/9/2015	<i>Micrococcus luteus</i> , <i>Staph. Caprae</i> , <i>Staph. saprophyticus</i>		
9/14/2015	<i>Staph. Saprophyticus</i> , <i>Staph. caprae</i> , <i>Micrococcus luteus</i>		
9/14/2015	<i>Micrococcus luteus</i>	<i>Acinetobacter johnsonii</i> ,	
9/15/2015	<i>Micrococcus luteus</i> , <i>Staph. Haemolyticus</i>	<i>Staph. pasteuri</i>	<i>Acinetobacter baumannii</i>
9/15/2015	<i>Micrococcus luteus</i>	<i>Acinetobacter</i> sp., <i>Acinetobacter lwoffii</i>	<i>Acinetobacter baumannii</i>
9/15/2015	<i>Micrococcus luteus</i>	<i>Acinetobacter</i> sp., <i>Acinetobacter lwoffii</i>	<i>Acinetobacter baumannii</i>
9/15/2015	<i>Staph. Hominis</i> , <i>Micrococcus luteus</i>	<i>Arthrobacter</i> sp.	
9/16/2015	<i>Micrococcus luteus</i> , <i>Staph. Epidermidis</i>		
9/16/2015	<i>Micrococcus luteus</i>		<i>Pseudomonas stutzeri</i> , <i>Acinetobacter baumannii</i>
9/16/2015	<i>Micrococcus luteus</i> , <i>Staph. hominis</i> , <i>Candida guilliermondii</i>	<i>Acinetobacter johnsonii</i> , <i>Roseomonas mucosa</i>	
9/16/2015	<i>Micrococcus luteus</i> , <i>staph. Epidermidis</i> , <i>Staph. warneri</i>	<i>Rhodobacter</i> sp.	
9/16/2015	<i>Staph. Epi</i> , <i>Micrococcus luteus</i>	<i>Bacillus thuringiensis</i> , <i>Wautersiella falsenii</i> , <i>Fungus</i>	
9/16/2015	<i>Micrococcus luteus</i> , <i>Staph. haemolyticus</i>	<i>Bacillus</i> sp., <i>Fungus</i>	
9/16/2015	<i>Micrococcus luteus</i> , <i>Staph. Warneri</i> , <i>Staph. Saprophyticus</i> , <i>Moraxella</i> sp.		
9/16/2015	<i>Corynebacterium</i> sp., <i>Staph. Hominis</i>	<i>Kocuria palustris</i> , <i>Kocuria rhizophila</i>	
9/17/2015	<i>Micrococcus luteus</i> , <i>Staph. Epi</i> , <i>Staph. haemolyticus</i>		
9/17/2015	<i>Staph. Epi</i> , <i>Micrococcus luteus</i>	<i>Bacillus</i> sp., <i>Acinetobacter johnsonii</i> , <i>Chryseobacterium indologenes</i> , <i>Fungus</i>	

as a neutral sphere in which experience is not challenged." It is amazing how many transitional objects find their way from home to hospital as one of many techniques to reduce children's anxiety, especially in surgical care [12,17–19].

Might these children's "best friends" pose specific medical risks? With the exception of severe cases of keratitis and corneal ulceration reported in the literature in children due to synthetic fibers from stuffed toy animals [20–24], previous studies have not evaluated the risk of infection from these potential carriers. The purpose of this study was to evaluate how stuffed toys brought into the operating room by children might contribute to the overall

bacterial load to which open surgical wounds are exposed during surgery. The results show that introducing these unconventional transmission agents into the operating room can have a significant, potentially pathogenic contribution to bacterial loads, which could increase the risk of SSI.

The high rate of bacterial contamination of stuffed animals was already stressed by Hughes et al. in 1986 [25]. Held et al. [26] demonstrated that washing an item of comfort (e.g., stuffed animal) 1 day before surgery effectively sterilizes that item. For elective surgeries, they recommend that families wash items that will accompany the child to the operating room 1 day before

Fig. 1. Pictures taken of all teddy bears analyzed.

surgery, sealing the object in a plastic bag to maintain sterility. However, this procedure cannot be used for children who undergo unplanned surgery (as in the trauma cases in the present study).

Compared to the Held study [26], we performed specific culture studies of all samples and made complete identification of the many different bacterial species. Most bacteria were nonpathogenic and saprophytic, but potential pathogenic germs were identified in eight cases.

There are several limitations to this study. Despite the identification of several pathogenic bacterial species, the patients of our cohort were not followed over the long term to monitor the development of SSIs. Therefore, no conclusion regarding a cause-and-effect relationship between the presence of a contaminated teddy bear and the development of an SSI can be drawn. Further research will be needed to determine whether a causal relationship

exists between the presence of contaminated patient belongings in the operating room and SSI. Since major orthopedic surgeries (e.g., neuromuscular spine correction, malignant tumor resections) may be performed on pediatric patients, providers must develop preventive measures to decrease the risk of bacterial infection in this vulnerable population. Our results were obtained in a cohort of trauma patients without any previous history of pathological conditions. However, the bacterial contamination of teddy bears of children who are frequently hospitalized is probably higher, with an increased ratio of pathogenic bacteria.

Although it is unlikely that contaminated teddy bears in the operating room are a major cause of SSI, the presence of these items contributes to the overall bacterial load to which surgical wounds are exposed. Neutralization of these contaminated items by families and caregivers may be a simple and effective part of the effort to prevent SSI by decreasing the overall bacterial load within the sterile environment of the operating suite. Parents' and doctors' visual evaluation of teddy bear cleanliness and fluffiness may lead to the suggestion that children and families bring a new, clean teddy bear for planned surgeries; however, as demonstrated by Gelman et al. [27] in a study of thirty-six 3-year-old children, children prefer their original, worn toy over a new replica.

Since conducting this study, all teddy bears admitted to our institution are now placed in a sealed plastic bag before entering the operating suite (Fig. 2).

Table 2
Statistical relation between the fluffiness and the level of contamination.

Fluffiness	Number (%)	Mean CFU	SD	95% CI
Stage 1	1 (2%)	95		
Stage 2	26 (49%)	105.6	128.1	16
Stage 3	20 (38%)	238.2	172	75.4
Stage 4	5 (9%)	530.2	233.2	204.3

SD: standard deviation; CI: confidence interval; CFU: colony-forming unit.

Fig. 2. Sealed bag used to allow the teddy bear in the surgical room.

5. Conclusion

Despite their documented benefits for the child, teddy bears are not appropriate in the surgical room. A sealed plastic bag could help reduce the bacterial load induced by the teddy bear.

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Disclosure of interest

The authors declare that they have no competing interest.

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