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The Current Debate on the Contamination of Baby Food With a Toxin Produced By Bacillus Cereus. Mini-Review of the Current State of Medical Knowledge on this Pathogen

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1. Introduction

Daily newspapers are currently reporting on extensive recalls of baby food due to contamination with Bacillus Cereus (BC) or its spores and toxins. It is surprising that the manufacturer of the contaminated additive in the form of arachidonic acid oil from China is hardly the focus of the reporting, while the companies that market the end product are facing considerable damage to their reputation and a slump in their share prices. From a medical point of view, there are reports of infants with vomiting and diarrhoea, and individual deaths observed in connection with BC-contaminated baby food are now also being investigated. From an epistemological point of view, it seems important to me that changes in the composition of industrially produced baby food should only ever be made in comprehensible and verifiable individual steps, so that the effects and potential side effects can be related to one additive at a time. The simultaneous addition of several additives, including arachidonic acid [1], does not allow for such differentiated assessments and may be associated with biostatistical errors [2]. In order to contribute to an objective debate, the following mini-review reports on the current state of knowledge on BC based on a PubMed search conducted on January 2026.

2. Methodology

As of January 2026, no fewer than 11,335 articles mentioning Bacillus Cereus (BC) in the title or abstract can be found in the PubMed medical database. In January 2023, McDowell et al. published a short review citing 15 sources, which referred to the epidemiology, complications and prognosis of BC infections, among other things. Infancy was not addressed [3]. Thirty years earlier, Drobniewski from London published a review on BC [4], which has been cited 1,178 times to date (Google, January 2026). It reports on three children with septic pneumonia or endophthalmitis [5-7]. There are 102 articles specifically on the topic of BC in connection with infants [title and/or abstract].

3. Results

The following data stand out in the articles on infancy:

1. BC has been detected in baby food and breast milk since 1980.

Singh et al. from India detected BC in samples of baby food with a ‘high incidence’ as early as 1980 and assessed this evidence as a ‘public health hazard’, especially since BC in food and as a cause of mastitis in cows had already been reported between 1968 and 1974. Singh et al. also pointed out that BC ‘survives pasteurisation and boiling’, which means that it ‘persists during the manufacture of baby foods’ [8]. The microbiological laboratory methods used by Singh et al. to detect BC were based on reference books by Lord (1960) and MacFaddin (1976) [8]. BC was also detectable in breast milk samples [9]; this also applied to samples from breast milk banks (collection centres) [10].

2. BC exhibits significant temperature resistance

BC was detectable in breast milk samples and samples from breast milk banks before and after Holder pasteurisation at 62.5 degrees Celsius [9, 10]. Temperatures of up to 72 degrees Celsius do not solve the problem either and contribute to the destruction of other milk components [11]. Alternatively, various high-pressure processes are being discussed that can destroy BC on a relatively large scale without significantly altering other milk components [11]; see also Soni & Brightwell 2024 [12]. Models are now also available showing the extent to which BC cultures develop in the temperature range from 9 to 25 degrees Celsius [13]. In 2017, significant contamination of ‘retail prepackaged infant formula and ready-to-eat rice flour’ was reported in China [14]. It is interesting to note that BC has also been detected in hygienic wet wipes (baby wipes) [15].

3. Guidelines for the control of BC in baby food have been available since 1980

In Canada, microbiological guidelines for the control of spray-dried formula were published as early as 1980 [16], based on

expert meetings in Berlin (1976) and FDA and WHO data presented in Geneva, Switzerland [16]. Becker et al. (1993) from the Institute for Hygiene and Technology of Milk, Ludwig Maximilian University of Munich, Germany, detected BC in several products that were sold in several countries [17].

4. Temporal association between BC detection and sudden infant death syndrome (SIDS)

In 1993, a case-control study from Australia investigating sudden infant death syndrome (SIDS) pointed to contamination with heat-stable toxins [18].[1] In 2025, Goldwater and Gebien referred to this study, particularly with regard to the detection of BC toxins in connection with SIDS cases [19].

5. Maltodextrins promote BC growth

The growth of the diarrhoea-associated BC toxin is promoted by the simultaneous presence of maltodextrins in baby food [20].

6. Cinnamon bark extracts appear to limit BC growth

Trans-cinnamaldehyde (the main component of cinnamon bark) 'may serve as a potential natural antimicrobial in reconstituted infant rice cereal even when utilised at low concentrations, inhibiting both vegetative cells and spores of B. cereus' [21].

7. Baby bottles and intensive care instruments as further possible sources of BC

Rowan et al. drew attention to the possibilities and difficulties that can arise when cleaning baby bottles with regard to BC and BC toxins [22]. Redmond and Griffith showed that it is possible to clean baby bottles in such a way that BC is no longer detectable [23]. However, BC was also detected on the sensor used to control the air flow of a ventilator; this report contains further references on this specific topic [24]. In another case of sepsis, the central venous catheter was identified as the source of BC [25].

8. BC infections are rare in infants, but serious when associated with certain BC toxins

In 1998, a case of BC meningitis was reported in Paris in an infant with no evidence of immunodeficiency. Antibiotic treatment with imipenem and amikacin was successful [26]. Another report of severe BC meningitis can be found in Drazin et al. 2010 [27]. BC has also been described as the cause of endocarditis in a 5-month-old infant after heart surgery [28]. In Tübingen (Germany), a premature infant was treated for multiple intestinal perforations and other life-threatening complications associated with BC and its toxin; the following serious complications were observed: 'multiple intestinal perforations..., severe cardiovascular shock, anaemia, thrombocytopenia and disseminated intravascular coagulation, leading to periventricular leukomalacia, alopecia capitis and toxic epidermal necrolysis' [29]. A protracted course of sepsis was observed in a very small premature infant from Poland [30]. Breast milk has also been described as a source of bacteraemia in a premature infant [31]. Such courses are rare and depend, among other things, on the type of BC toxin: 'a bilingual search spanning 50 years identified 266 relevant studies on global B. cereus infection, encompassing 6,135 cases. The global mortality rate for B. cereus infection is 0.9%. Food poisoning cases account for 94.31% (5786/6135) of the total infections, with a mortality rate of 0.05%. B. cereus infections were primarily reported in East Asia, Europe, and North America, with frequent studies in eastern and southern China. Rice was recognised as the highest-risk food category for B. cereus-associated food poisoning, with 43 reported incidents. Younger populations, particularly infants and toddlers (<2 years) and school-age children (6- 18 years), tend to exhibit more severe symptoms. These symptoms include fulminant liver failure, rhabdomyolysis, and metabolic acidosis. The outcomes of severe cases are associated with specific toxin types, with cereulide-producing strains linked to complicated clinical disorders and outcomes '[32].

9. BC resistance situation (antibiotics)

Detailed studies on BC sensitivity to antibiotics are available from China: 'The antibiotic susceptibility test indicated that most of the B. cereus isolates were resistant to ampicillin, penicillin, cefepime, cephalothin, and oxacillin, and were susceptible to gentamicin, chloramphenicol, imipenem, tetracycline, ciprofloxacin, trimethoprim-sulfamethoxazole, erythromycin, kanamycin, and cefotetan.' [33]. When combating and preventing BC in the production of baby food, it is strongly recommended to also consider BC's ability to develop biofilms, whereby the surface structure of all materials used has a significant effect [34].

10. BC detection methods

Since 2009, a PCR method and a DNA microarray have been available for the detection of BC in baby food [35, 36], supplemented since 2015 by single molecule, real-time sequencing technology (SMRT) [37] and since 2016 by multiplex PCR [38]. In 2016, Izadi et al. presented an 'electrochemical DNA-based biosensor for Bacillus cereus detection in milk and infant formula' [39]; this method now appears to have become established and proven itself [40]. BC toxin genes can also be detected by laboratory chemistry [41, 42]. Nevertheless, laboratory detection of BC and assessment of temperature sensitivity remain a significant methodological challenge:'Bacillus cereus sensu lato is one of the most harmful bacterial groups affecting the quality and safety of powdered infant formula (PIF). In this study, samples were collected from the raw materials and processing environments of PIF [powdered infant formula]. A total of 84 isolates were identified as Bacillus cereus sensu stricto (B. cereus s. s.) by 16S rRNA analysis, molecular typing technology, and physiological and biochemical tests…… Results showed that the 84 isolates were clustered into 24 sequence types (ST), and 14 novel ST were detected….. The correlation between processing areas and ST showed that the processing environments of the production and packing areas were the most susceptible to contamination by B. cereus s. s. Spores of these ST showed different heat resistance phenotypes evaluated by the analysis of DT (time in minutes of spore decimal reduction at each temperature) and Z values (temperature increase required to reduce the DT value to one-tenth of the original).' [43]. These differentiat-

ed considerations may not yet represent the final conclusion, as extensive research on BC phylogeny has been presented since Robert Koch's discovery of the anthrax pathogen: 'These notions support the idea that the B. cereus sensu lato group is in part "hopeful monsters" that can be transformed into new pathogenic lineages under the right set of circumstances.' [44]The practical significance of this marked heterogeneity of BC types was demonstrated in 2025 in samples from Canadian breast milk banks collection centres [10]. It remains to be seen whether the detection methods published in 2026 will be able to resolve the diagnostic knot [45, 46].

11. Conclusion

BC has been known for several decades. BC infections are relatively rare; however, in the presence of certain toxin types and/or in premature infants, they can cause serious, life- threatening diseases. BC has been detected not only in industrially produced baby food, but also in breast milk and in samples from breast milk banks. The diagnosis and prevention of BC infections poses a significant diagnostic and interventional challenge, which will certainly contribute to the adaptation of current guidelines and recommendations. This is not only a matter for baby food manufacturers, but also for parents and carers of infants in hospitals, as the cleaning of baby bottles, among other things, is important in the context of BC prevention.

12. Footnotes

1 "Heat-labile toxin, lethal to mice (HLML) was found in 32 (27.1%) of 118 SIDS faecal samples compared with 5 (10.6%) of 47 healthy babies (chi 2 = 5.24, $p < 0.05$); cytotoxins in 38 (30.9%) of 123 SIDS faecal samples compared with 0 of 21 healthy babies (chi 2 = 8.8, $p< 0.01$) and 24 (27.6%) of 87 SIDS serum samples." [18].

2 "The three main species of Bacillus cereus sensu lato, B. cereus, B. thuringiensis, and B. anthracis, were recognised and established by the early 1900s because they each exhibited distinct phenotypic traits. B. thuringiensis isolates and their parasporal crystal proteins have long been established as a natural pesticide and insect pathogen. B. anthracis, the etiological agent for anthrax, was used by Robert Koch in the 19th century as a model to develop the germ theory of disease, and B. cereus, a common soil organism, is also an occasional opportunistic pathogen of humans. In addition to these three historical species designations, there are three less-recognised and less-understood species: B. mycoides, B. weihenstephanensis, and B. pseudomycoides. All of these 'species' combined comprise the Bacillus cereus sensu lato group. Despite these apparently clear phenotypic definitions, early molecular approaches to separate the first three by various DNA hybridisation and 16S/23S ribosomal sequence analyses led to some 'confusion' because there were limited differences to differentiate between these species. These and other results have led to frequent suggestions that a taxonomic change was warranted to reclassify this group to a single species. However, the pathogenic properties of B. anthracis and the biopesticide applications of B. thuringiensis appear to have outweighed pure taxonomic considerations, and the separate species categories are still being maintained. B. cereus sensu lato represents a classic example of a now common bacterial species taxonomic quandary" [44].

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