Characterization of the bacterial makeup and quantitative distribution in patients with suspected small intestine bacterial overgrowth (SIBO): A meta-analysis

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Introduction

Small Intestine Bacterial Overgrowth (SIBO) is a clinical condition associated with abnormally high bacterial counts in the small intestine and clinical features such as diarrhea, constipation, abdominal pain, distension, and bloating. A meta-analysis of studies of endoscopic samples from patients with suspected SIBO was performed to estimate the distribution of bacterial colony forming units (CFU), and a review was performed to identify the bacterial populations in these patients.

Methodology

A literature search was performed to find relevant studies using the following keywords: SIBO (or SBBO), culture aspirate, and CFU. Ten studies with data on patients with culture aspirates from the jejunum or duodenum were found. The CFU distribution was estimated using a log-spline smoothing technique in the statistical package R. In addition, a literature review was performed to identify the bacterial populations in jejunal aspirates of these patients.

Study	Study population	Ν	Aspirate culture taken from	Type of data
1. Bardhan et al. 1992	Adults with various gastrointestinal diseases	26	Proximal small bowel	All counts (continuous)
2. Berthold et al. 2009	Adults with suspected SBBO	22	Region of the ligament of Treitz	All counts (continuous)
3. Corazza et al. 1990	Adults with suspected SBBO	30	Jejunum	All counts (continuous)
4. Ghoshal et al. 2014	Adults with IBS	80	Upper small bowel	CFU<10 ³ , continuous for counts $\geq 10^3$
5. Lewis et al. 1997	Adults with suspected SBBO	47	Duodenum	CFU<10 ³ , continuous for counts \geq 10 ³ , one count reported as <10 ⁵
6. Riordan et al. 1995	Adults with suspected SBBO	15	Duodenum	CFU<10 ³ , continuous for counts \geq 10 ³ , one count reported as <10 ⁵ , one count reported between 10 ⁴ and 10 ⁵
7. Riordan et al. 2000	"Hydrogen producer" Adults with suspected SBBO	20	Proximal small intestine	CFU<10 ³ , 10 ³ ≤CFU<10 ⁵ ,CFU≥10 ⁵
8. Erdogan et al. 2015	Adults with suspected SBBO	139	Duodenum	CFU<10 ³ , 10 ³ ≤CFU<10 ⁵ ,CFU≥10 ⁵
9. Jacobs et al. 2013	Adults with suspected SBBO	150	Duodenum	$CFU < 5x10^3$, $5x10^3 \le CFU < 10^4$, $10^4 \le CFU < 5x10^4$, $5x10^4 \le CFU < 10^5$, $CFU < 10^5$
10. Posserud et al. 2007	Adults with IBS	162	Jejunum	CFU<5 x 10 ³ , $5x10^3 \le CFU < 10^4$, $10^4 \le CFU < 5x10^4$, $5x10^4 \le CFU < 10^5$, $CFU \ge 10^5$

Table 1. Summary of the studies used to estimate the distribution of bacterial CFU/mL, separated into groups by the type of CFU data presented.

Results

 Table 1 presents a summary of the studies used in the meta
analysis, with the number and type of subjects, and the region the culture aspirate sample was taken from, separated by the type of CFU data presented. Figure 1 presents a histogram of the estimated CFU distribution using studies 1-5 with distinct CFU counts (raw viable plate counts, with total aerobic plus anaerobic counts); the remaining studies (6-10) presented CFU counts in categories. The spike at zero reflects that approximately 26% of patients had sterile cultures.

Sensitivity analyses using studies 1-7 and all studies were done, which yielded similar estimated distributions to Figure 1, particularly in terms of the proportion of subjects with CFU counts between 10⁴ and 10⁶. The proportion of subjects in the tails of the distributions (either with sterile samples or with CFU counts greater than 10¹⁰) had larger variations between the three fitted distributions presumably due to differences in counting methodologies. Table 2 summarizes the top bacterial species cultured and typed from jejunal aspirates as well as the studies used to describe the strain list.

Table 2. Summary of the top bacterial species cultured and identified from j	jej	jui
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Organism	Gram reaction	References
Escherichia coli	NEG	Pistiki et al. 2014.; Bouhnik et al. 1999.; Posseru Ghoshal et al. 2014.; Pyleris et al. 2012.; Rumes
Staphylococcus spp.	POS	Pistiki et al. 2014.; Bouhnik et al. 1999.; Posser Ghoshal et al. 2014.; Pyleris et al. 2012.; Rumes
Klebsiella pneumoniae	NEG	Pistiki et al. 2014.; Bouhnik et al. 1999.; Posser Ghoshal et al. 2014.; Pyleris et al. 2012.; Rume
Pseudomona aeruginosa	NEG	Pistiki et al. 2014.; Giamarellos-Bourboulis et a
Clostridium spp.	POS	Bouhnik et al. 1999.; Posserud et al. 2007.; Gia Riordan et al. 2000.; Berthold et al. 2009.; Kerc
Bacteroides spp.	NEG	Bouhnik et al. 1999.; Erdogan et al. 2015.; Rum
Enterobacter aerogenes	NEG	Pistiki et al. 2014.; Posserud et al. 2007.; Erdog
Streptococcus spp.	POS	Bouhnik et al. 1999.; Erdogan et al. 2015.; Gho
Enterococcus faecalis	POS	Pistiki et al. 2014.; Posserud et al. 2007.; Erdog
Proteus mirabilis	NEG	Bouhnik et al. 1999.; Giamarellos-Bourboulis et

NEG = Gram-negative, POS = Gram-positive



Figure 1. Estimated distribution of bacterial CFU in patients with suspected SIBO using the five articles with complete data.



ud et al. 2007.; Giamarellos-Bourboulis et al. 2015.; Erdogan et al. 2015.; ssen et al. 1985.; Riordan et al. 2000.; Berthold et al. 2009.; Kerckhoffs et al. 2015. erud et al. 2007.; Giamarellos-Bourboulis et al. 2015.; Erdogan et al. 2015.; ssen et al. 1985.; Riordan et al. 2000.; Berthold et al. 2009.; Kerckhoffs et al. 2015. erud et al. 2007.; Giamarellos-Bourboulis et al. 2015.; Erdogan et al. 2015.; essen et al. 1985.

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nessen et al. 1985.; Riordan et al. 2000.; Kerckhoffs et al. 2015.

gan et al. 2015.; Pyleris et al. 2012.

oshal et al. 2014.

an et al. 2015.; Pyleris et al. 2012.; Berthold et al. 2009.; Kerckhoffs et al. 2015.

al. 2015.; Pyleris et al. 2012.; Rumessen et al. 1985.

Conclusions

- Using the standard diagnostic threshold of 10⁵ CFU, only 24% of patients with suspected SIBO would test positive; lowering the threshold to 10⁴ CFU yields 33% of patients with suspected SIBO testing positive.
- As expected, bacterial culture identification was unable to clearly distinguish a single contributing organism.
- Limitations to this work include variability in sampling regions, contamination, difficulty culturing and counting bacteria, lack of standardization in procedures and reproducibility.
- Given these limitations, there is consensus that novel tools are needed for evaluating patients with suspected SIBO.