Borders of the A_0-Concept in Theory and Practice

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Introduction

- The aim of disinfection is to prevent the transmission of pathogenic microorganisms
- This is achieved by reduction of defined groups of pathogens by killing or irreversible inactivation to a defined level (mostly to an extent of a reduction of ≥ 5 log steps)
- Most of the disinfection procedures are not aimed at killing bacterial spores

Introduction

- For a long time temperature-time-combinations that are confirmed to be effective were used for thermal disinfection
- Because the heat resistance of different microorganisms varies a lot it is difficult to define general conditions for a safe thermal inactivation
- By release of the EN ISO 15883-1 in 2005 the A_0-Concept, a mathematical model for the calculation of the disinfection efficacy, has been introduced

The A_0-Concept

- A_0-Value = Specifies the relation between temperature and exposure time to achieve a defined inactivation of microorganisms

The Formula

$$A_0 = \sum 10^{\frac{T-80}{z}} \Delta t$$

A_0	Time equivalent in seconds at 80 C to reach a certain efficacy of disinfection when the z-value=10
T	Temperature of the load in C
Z	z-value in C
Δt	chosen time interval in seconds

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z = Temperature change required to achieve one log reduction in the D-value

D = Time (min) needed to reduce the cell count of a certain microorganism to one tenth

A_0-Table

Temp.	Time to reach A_0=3000 (critical MDs)		Time to reach A_0=600 (semicritical MDs)		Time to reach A_0=60 (uncritical MDs)	
	sec	min	sec	min	sec	min
65	94868	1581,1 (26 h)	18974	316,2 (5h)	1897	31,6
70	30000	500,0 (8h)	6000	100,0	600	10,0
75	9487	158,1	1897	31,6	190	3,2
80	3000	50,0	600	10,0	60	1,0
85	949	15,8	190	3,2	19	0,3
87	599	10,0	120	2,0	12	0,2
90	300	5,0	60	1,0	6	0,1
93	150	2,5	30	0,5	3	0,1
95	95	1,6	19	0,3	2	0,03

The A_0-Concept

- First mentioned in EN ISO 15883-1
- Deduced from the F-Concept for sterilisation in presumption of the analogy between sterilisation and disinfection with moist heat
- Not been proved by experimental tests before
- There are only little papers published about the thermal resistance of microorganisms
- Mainly studies about D-values
- The data available are partly contradictory

D-Value Data

65 °C	1,5 min	Pisot et al.
	22 min	**Buchrieser**
70 °C	21 sec	Pisot et al.
	3 min	**Buchrieser**
	3 min	Wendler
	2 - 5 min	Orr et al.
75 °C	4 sec	Pisot et al.
	20 sec	**Buchrieser**
	1 min	Wendler
	1,5 - 5 min	Orr et al.
80 °C	**3 sec**	**Buchrieser**
	47 s	Wendler
	1,3 – 4 min	Orr et al.
85 °C	**1 sec**	**Buchrieser**
	47 s	Wendler
	1,2 – 4 min	Orr et al.

Theory and Practice

- Following the F-Concept (steam sterilisation at 121 C/15 min) a few seconds at 134 C would be sufficient to achieve the same reduction factor - in fact 3 Minutes at 134 C are required in the standards
- Therefore „flash sterilisation“ is not realizable because microorganisms microorganisms are not inactivated from the first second on
- The cell count plays a major roll – the more there are the easier it is to kill 90 % of the germs

Theory and Practice

- In the temperature range up to 80 C there are considerable deviances regarding the resistance of microorganisms
- The unability of determining the kinetics of killing require a safety margin in reprocessing of MDs
- Regarding the high microbial contamination in combination with a high soiling in clinical practice there are considerable gaps between mathematical calculation and real conditions

Theory and Practice

- In literature it is generally accepted that at lower temperatures the inactivation rate do not follow first order kinetics which was assumed in the A_0-concept

- Taking into account that the z-value is not directly dependent on the thermo-resistance of a microorganism the z-value of 10 C seems to be chosen by chance

Objective of the Study

- To evaluate the validity of the A_0-Concept from a microbiological point of view

- To assess the A_0-values recommended in EN ISO 15883 and by the Austrian Society for Sterile Supply (ÖGSV) respectively from a practical (hygienical) point of view

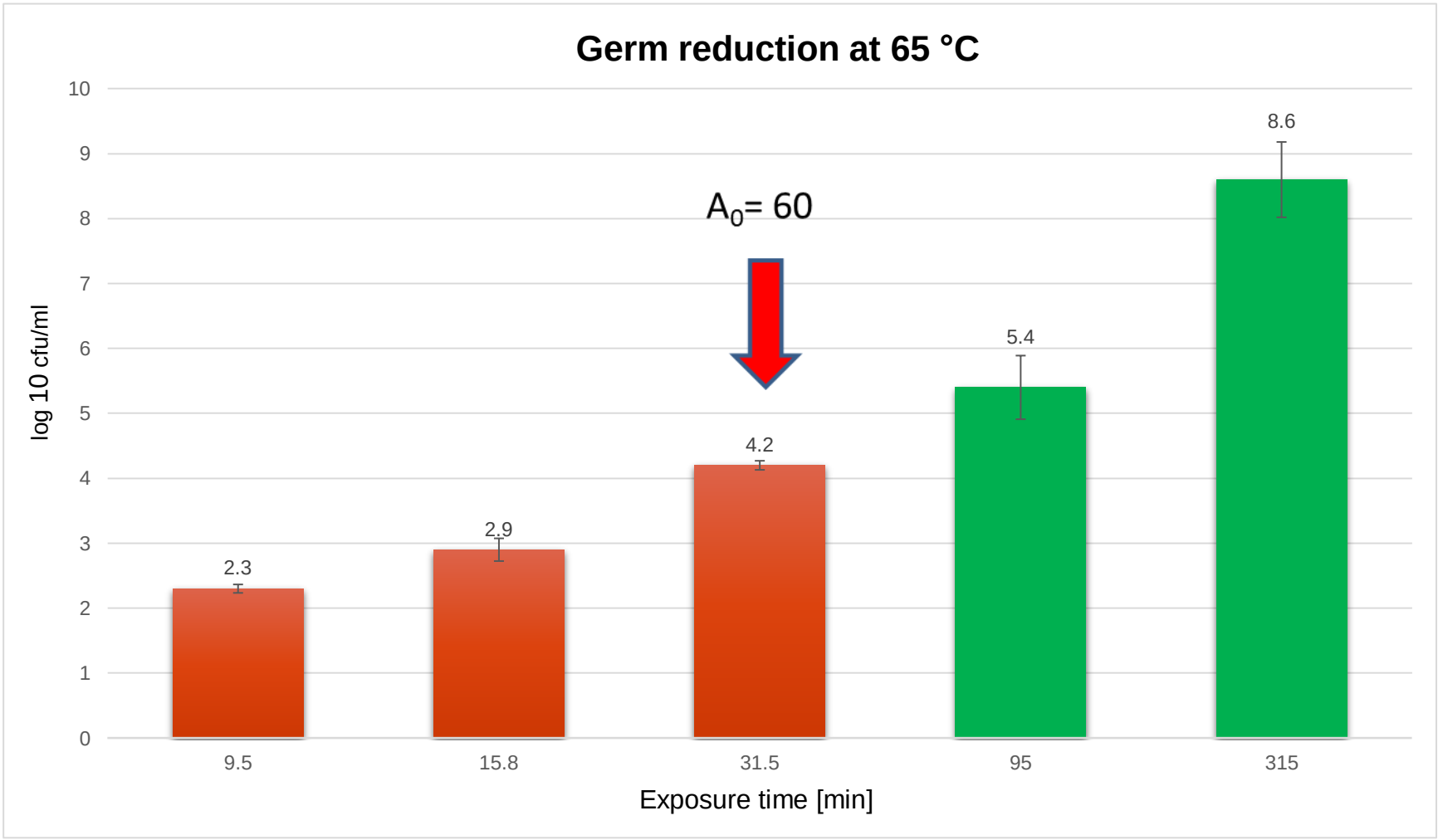
Method

- Test organism:
  Enterococcus faecium ATCC 6057
  (known as one of the most heat resistant vegetative bacteria and thus test organism for thermal disinfection)
- Suspension with a cell count of
  $2\text{-}3*10^{10}$ cfu/ml in physiologic salt solution
- Heating up in a water bath
- Different temperatures and exposure times :
  65-95 C at 5 C steps, accuracy 0.5 C
- Cooling down in an ice bath of 4 C
- 6 times replication

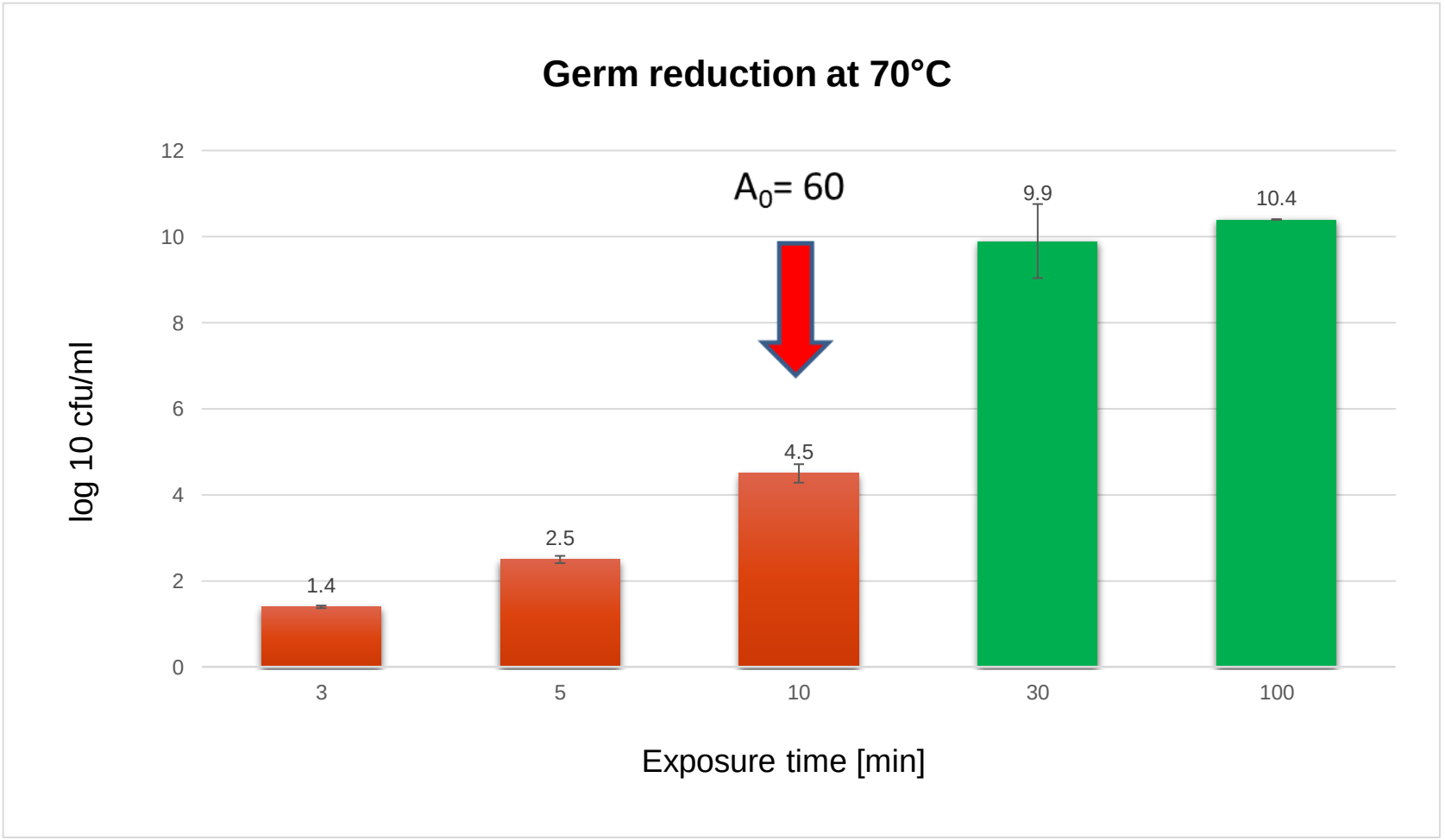
Method

- Decimal dilution row
- 100 µl of each dilution plated on Trypton Soy Agar
- Incubation for 7 days at 36 1 C and 7 more days at room temperature (23 2 C)
- Reduction factor (RF) determined by comparison with untreated control

Results

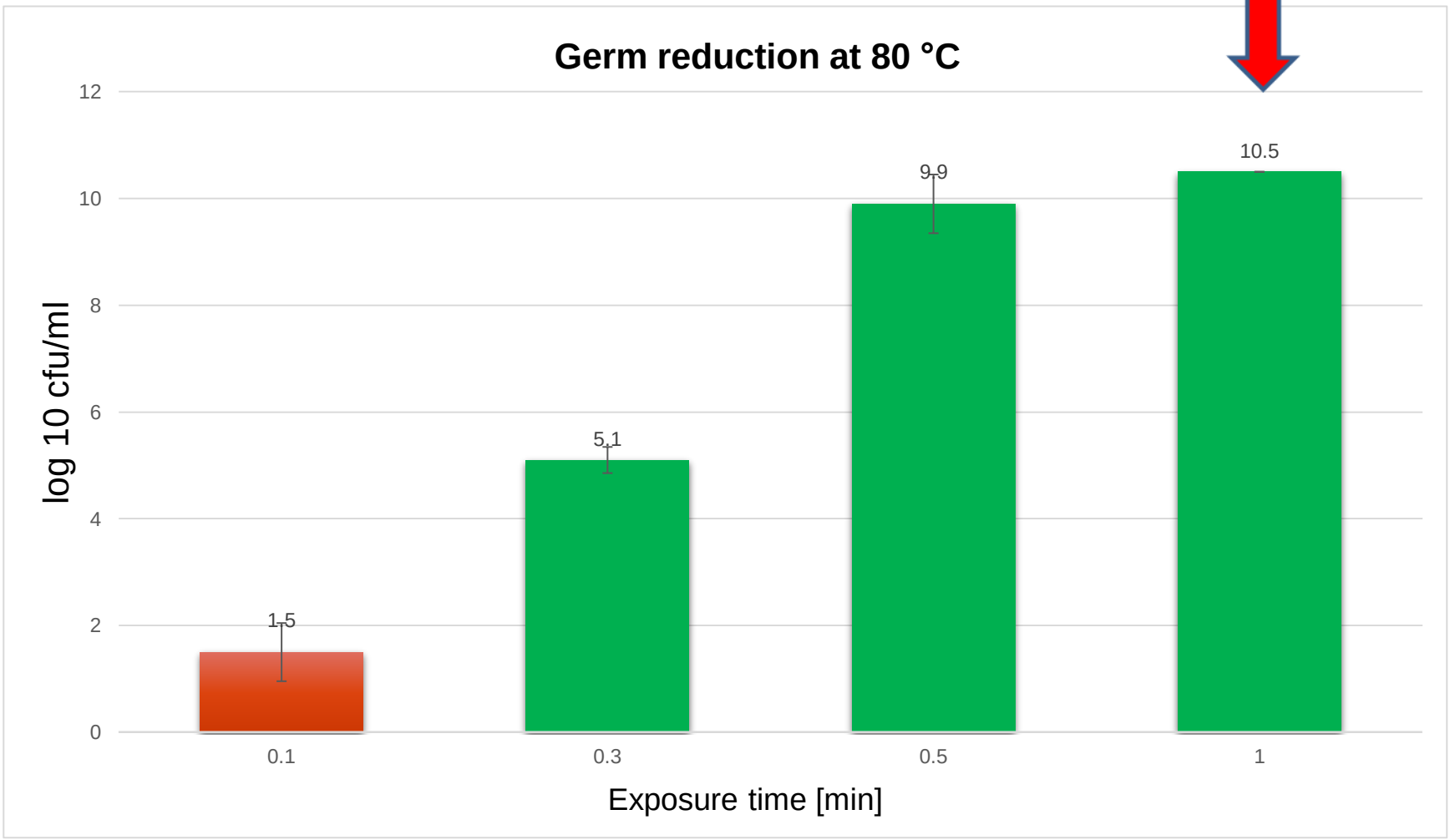

Germ reduction at 65 °C
log 10 cfu/ml
10
9
8
7
6
5
4
3
2
1
0
A_0= 60
2.3
2.9
4.2
5.4
8.6
9.5
15.8
31.5
95
315
Exposure time [min]

Results

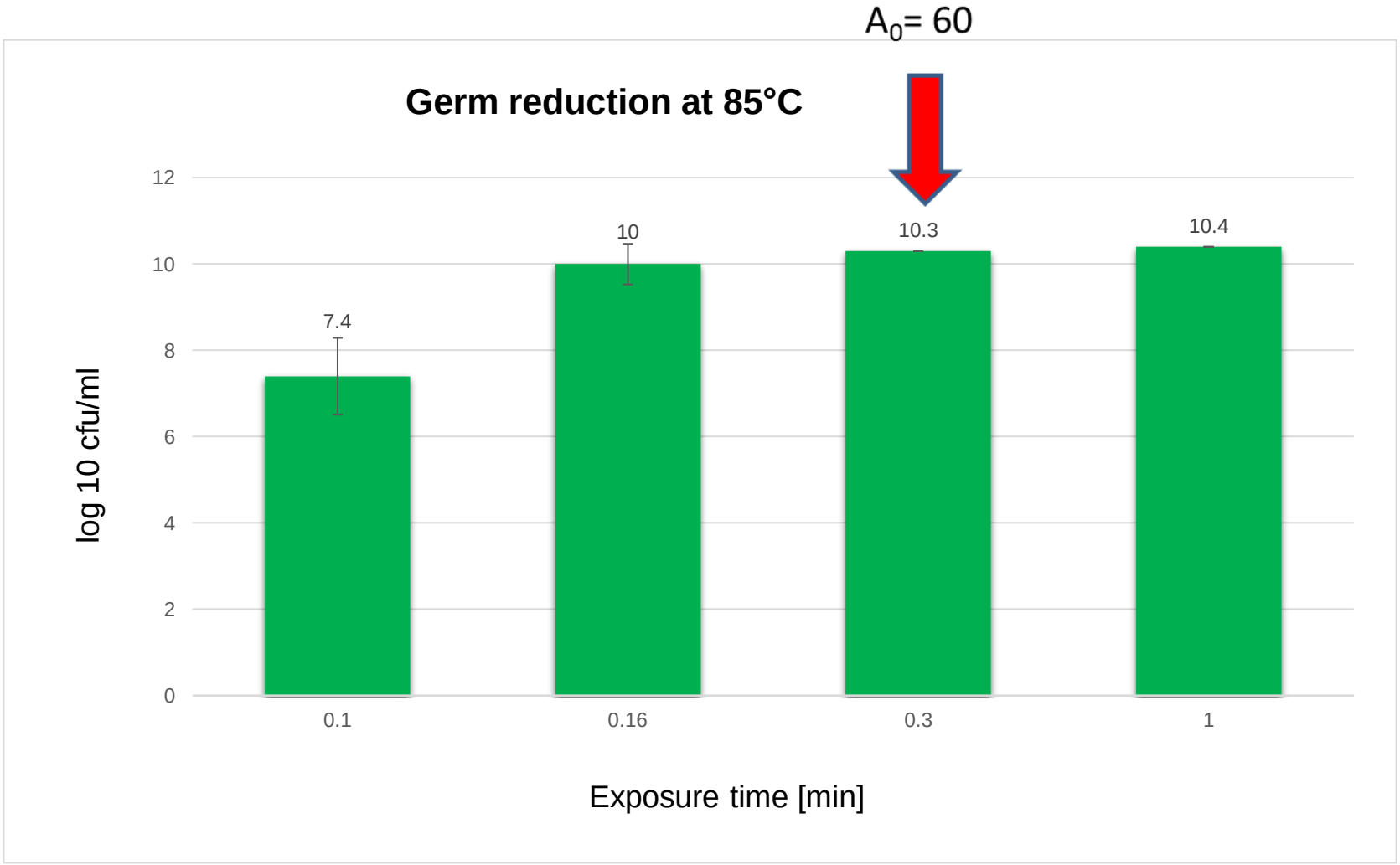

Germ reduction at 70°C
log 10 cfu/ml
12
10
8
6
4
2
0
A_0= 60
1.4
2.5
4.5
9.9
10.4
3
5
10
30
100
Exposure time [min]

Results

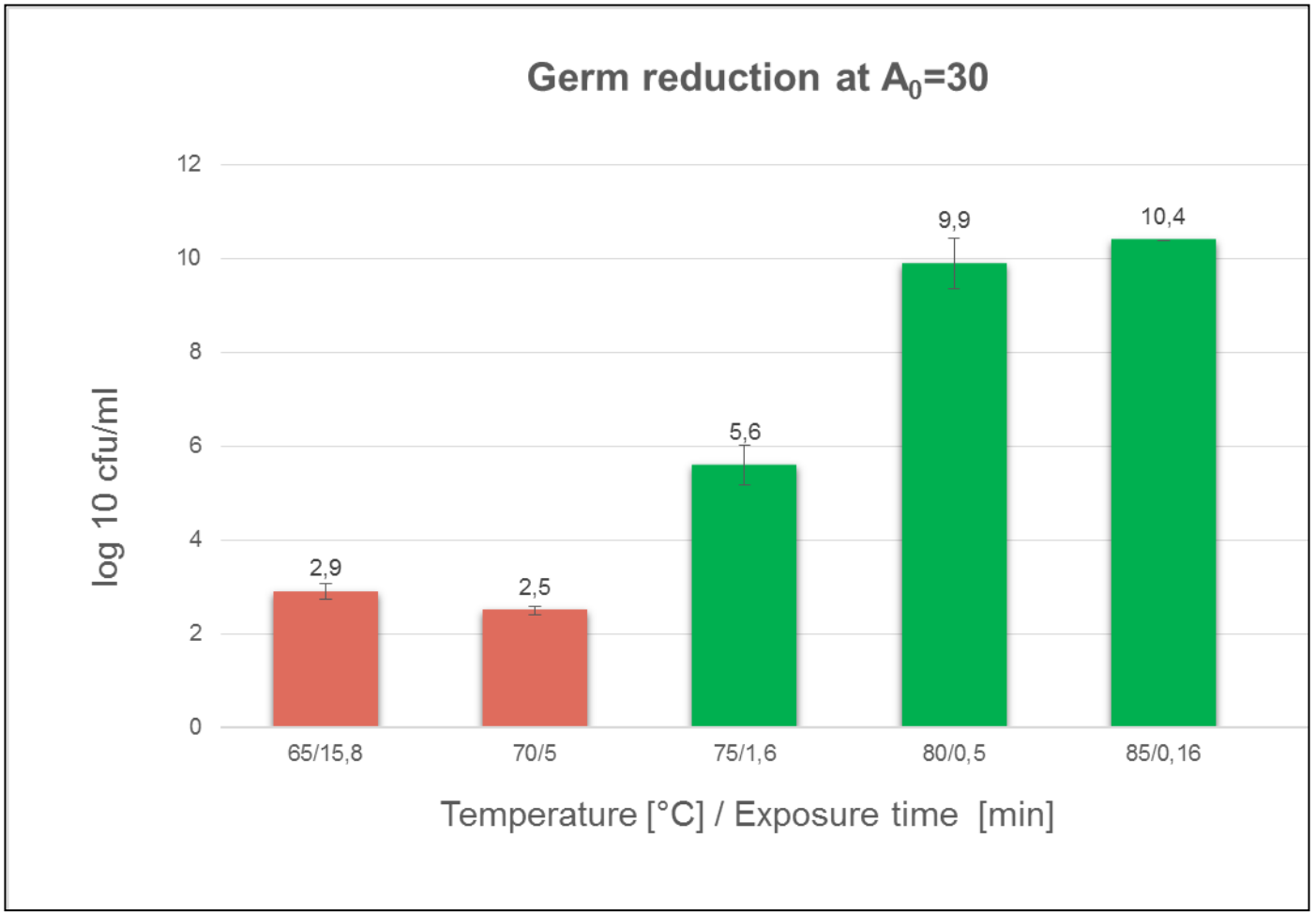
A_0= 60



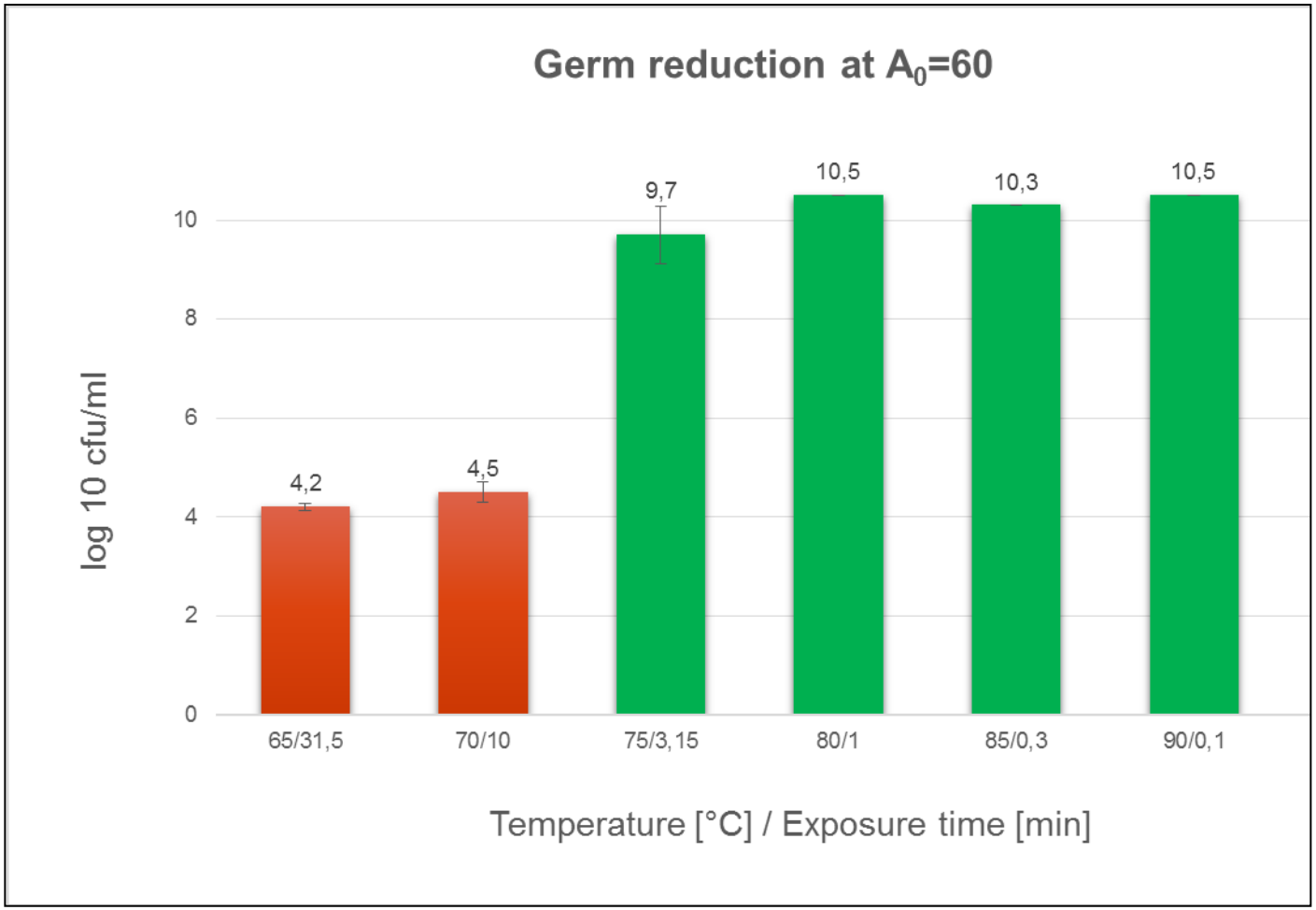
Results


A_0= 60
Germ reduction at 85°C
log 10 cfu/ml
12
10
8
6
4
2
0
7.4
10
10.3
10.4
0.1
0.16
0.3
1
Exposure time [min]

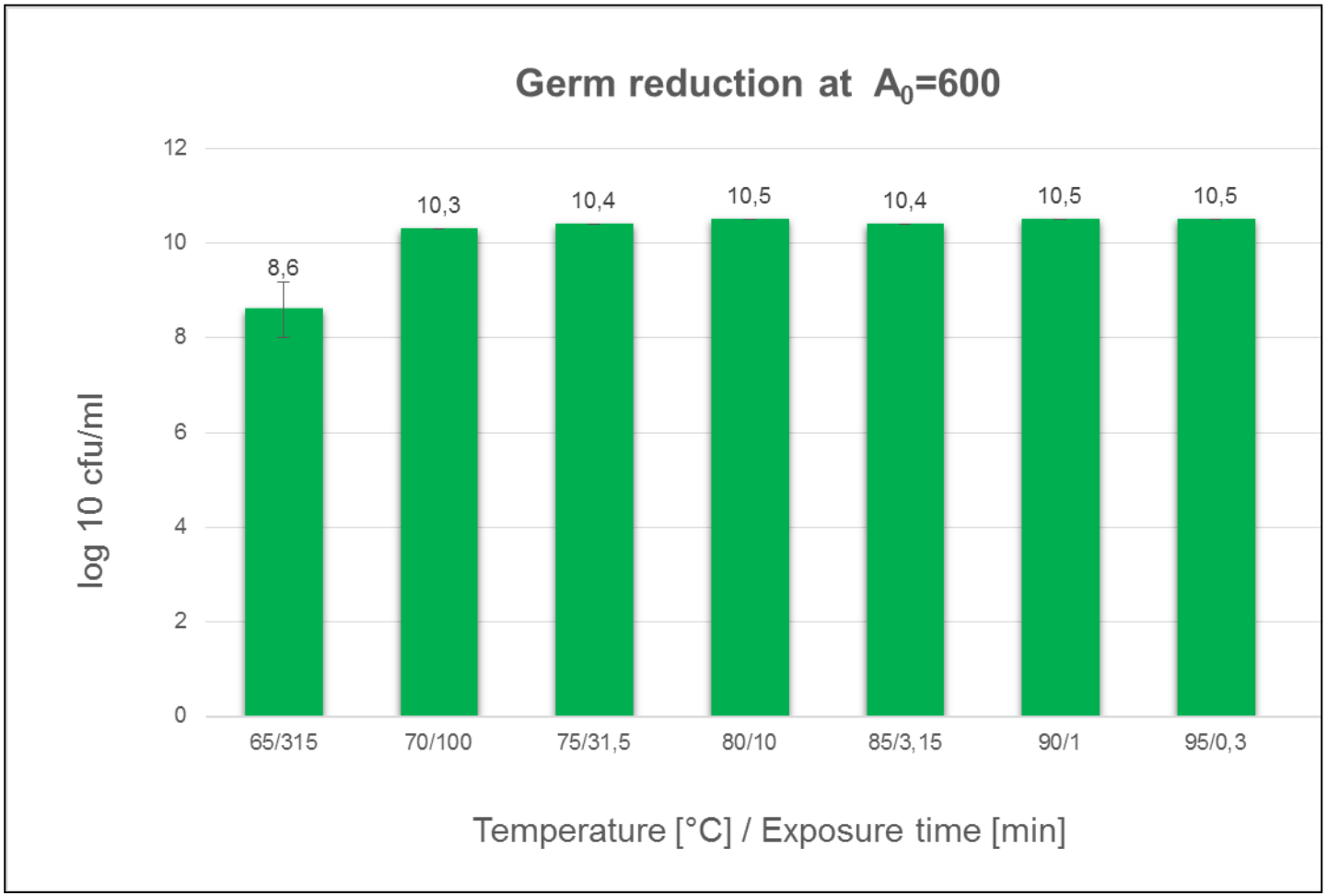
Results


Germ reduction at A_0=30
log 10 cfu/ml
12
10
8
6
4
2
0
2,9
2,5
5,6
9,9
10,4
65/15,8
70/5
75/1,6
80/0,5
85/0,16
Temperature [°C] / Exposure time [min]

Results


Germ reduction at A_0=60
log 10 cfu/ml
0
2
4
6
8
10
4,2
4,5
9,7
10,5
10,3
10,5
65/31,5
70/10
75/3,15
80/1
85/0,3
90/0,1
Temperature [°C] / Exposure time [min]

Results


Germ reduction at A_0=600
log 10 cfu/ml
12
10
8
6
4
2
0
8,6
10,3
10,4
10,5
10,4
10,5
10,5
65/315
70/100
75/31,5
80/10
85/3,15
90/1
95/0,3
Temperature [°C] / Exposure time [min]

Results

Total Germ Elimination (log RF > 10) after…

Temperature °C	Exposure time
65	?
70	100 min
75	9,5 min
80	1 min
90	12 sec
95	9,5 sec

Results

- The comparison of different temperature-time-combinations that result in the same A_0-value showed a difference in the germ reduction of up to 7.9 log levels

- The inactivation of *E. faecium* at lower temperatures and longer exposure times was never as effective as the inactivation at higher temperatures and shorter exposure times

Discussion

- The concept does not work in temperature ranges below 75 C
- A_0-Values of ≥ 180 at temperatures ≥ 80 C give a satisfactory disinfection effect with sufficient safety margin

Discussion

- For the disinfection of surgical instruments the standard recommends an A_0-value of 600, which seems to be sufficient from the bacteriological point of view

- This might not be valid for viruses (A_0 3000?)

Discussion

- The A_0-value of 60 given in EN ISO 15883 for the disinfection of bedpans may be too low considering that at this setting the inactivation of heat resistant enterococci in high cell count has to be achieved

- The A_0-value of 180 which is recommended by the ÖGSV for the disinfection of bedpans seems to be sufficient at temperatures ≥ 80 C

Summary

- Microorganisms do not behave like we expect it from them!
- Maybe someone forgot to explain the A_0-formula to them?

- The A_0 concept does not work in practice but…
- It may be applied at temperatures above 80 C

Enough?

THANK YOU

FOR YOUR ATTENTION!