

CVAD Lock Solutions –

Finding a Solution to Fight the Triple Threat of Clot Formation, Bacterial Colonization and Biofilm Formation



Jocelyn Hill – MN, RN, CVAA(c), VA-BC™

Providence Health Care, Vancouver, BC – Canada

Nurse Educator, IV Therapy/Vascular Access, Home Infusion, OPAT

Practice Consultant for BC Home TPN Program – Vascular access

Disclosures

- Nurse Educator – IV Therapy , Vascular Access, and Home Infusion Programs, Providence Health Care, Vancouver, BC Canada
- Past President – the Canadian Vascular Access Association (CVAA) Board of Directors
- Director at Large – Association of Vascular Access (AVA)
- Clinical Consultant (Canada)– Angiodynamics, BD Medical, Cook Medical



Objectives

1. Describe the elements of a Home TPN Program and the risk profile of patients with CVADs in the program.
2. Discuss and compare currently used catheter lock solutions and current literature on the topic.
3. Describe patient outcomes with the implementation of a lock solution to prevent the "triple threat" of CVAD clot formation, bacterial colonization and biofilm formation.

Our patients: n= 105

BC HPN PROGRAM - ADULT DIVISION – ACTIVE PATIENT SUMMARY			
	2013/2014 P13 (on Mar 31/14)	2014/2015 P13 (on Mar 31/15)	2015/2016 P13 (on Mar 31/16)
PATIENTS			
Male	27 (36%)	31 (38%)	34 (38%)
Female	47 (64%)	50 (62%)	56 (62%)
Total	74	81	90
AGE			
Average (y)	58	56	57
Range (y)	30-83	18-84	19-84
DURATION ON HPN			
Average (y)	8	8	7
Range*	1m-38y	1m-39y	1m-40y

Patient diagnoses

BC HPN PROGRAM - ADULT DIVISION – ACTIVE PATIENT SUMMARY			
PRIMARY DIAGNOSIS FOR HPN	2013/2014 P13 (on Mar 31/14)	2014/2015 P13 (on Mar 31/15)	2015/2016 P13 (on Mar 31/16)
Short Bowel Syndrome	35	35	38 (42%)
Intestinal Pseudo Obstruction (without SBS)	5	6	8 (9%)
Intestinal Fistulas	4	8	9 (10%)
Malabsorption	4	5	5 (5%)
Gastroparesis	1	3	3 (3%)
Mechanical Obstructions	0	1	2 (2%)
Scleroderma	2	2	2 (2%)
Chronic Pancreatitis	1	1	2 (2%)
Ischemic Bowel (without SBS)	0	0	1 (1%)
Hyperemesis Gravidarum	1	0	1 (1%)
Food Protein Intolerance, Pregnancy	0	0	1 (1%)

Short Bowel Syndrome =
majority of patients (73%)

Note: some patients have multiple diagnoses with complex GI tracts

* Other: Behcet's syndrome, Neurofibromatosis, Scleroderma, Gardner syndrome, MVA, Volvulus, Bariatric Surgery, etc.

CVAD complications and risks

CVADs:

- Tunneled: silicone, IVAD: silicone and polyurethane
- PICC: proximal valve, polyurethane
- **Occlusion**
- **Repair** — silicone lines
- **Infection** — site, intraluminal, systemic

RISKS:

High and ongoing due to chronic illness and dependence on TPN

Program goals

Prevention of/Decreased CVAD complications:

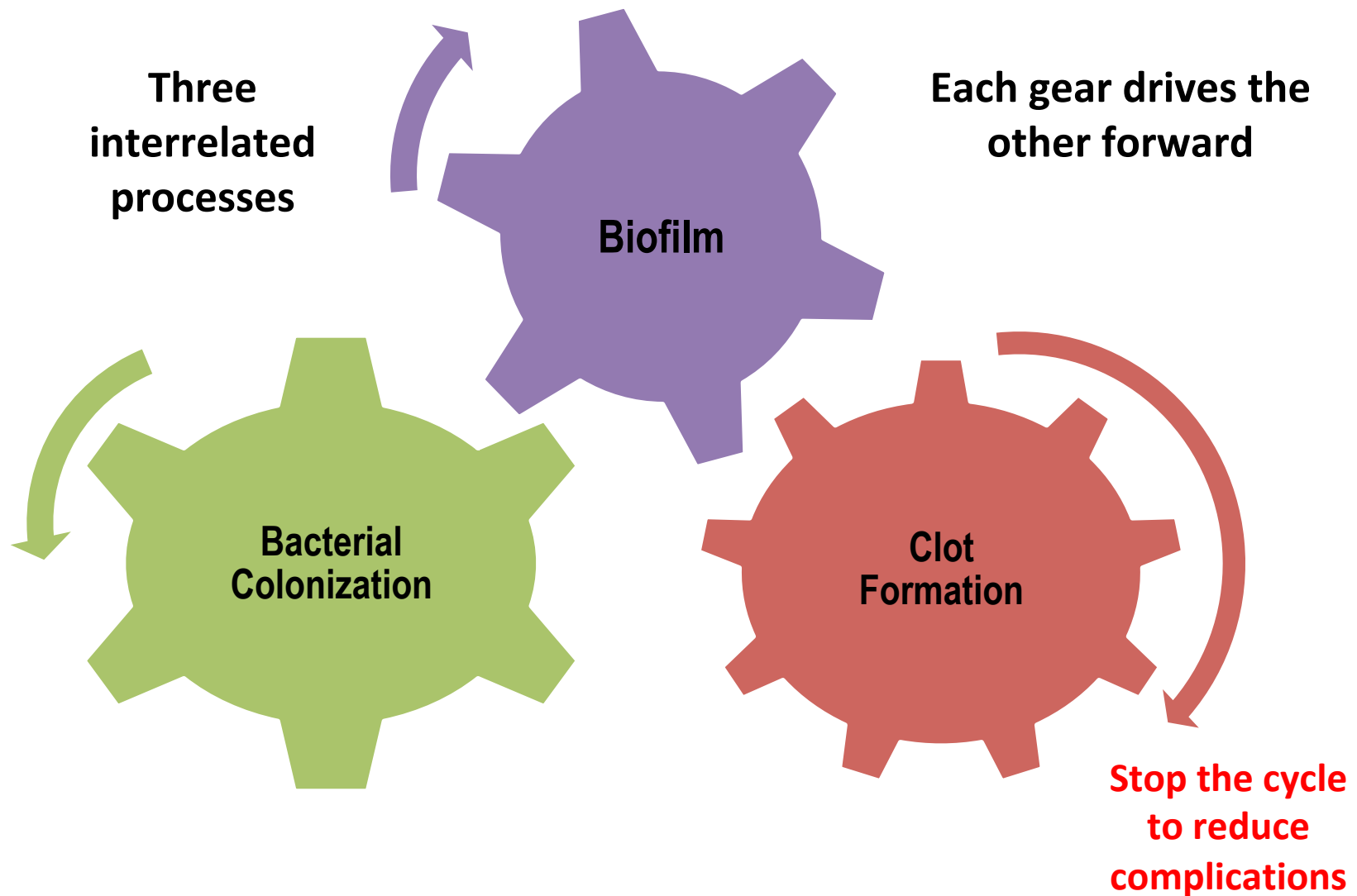
- Hospital admissions for CVAD complications
- Clinical interventions for CVAD complications
 - No occlusion, repair, infection, removal, exchange or replacement
 - Vessel preservation/catheter salvage

Save the line

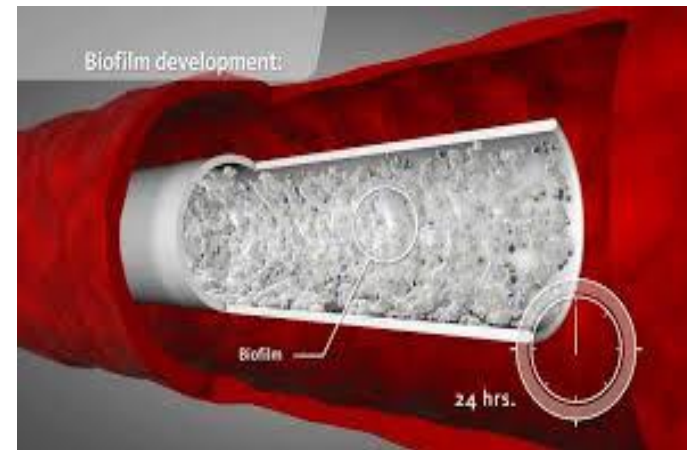
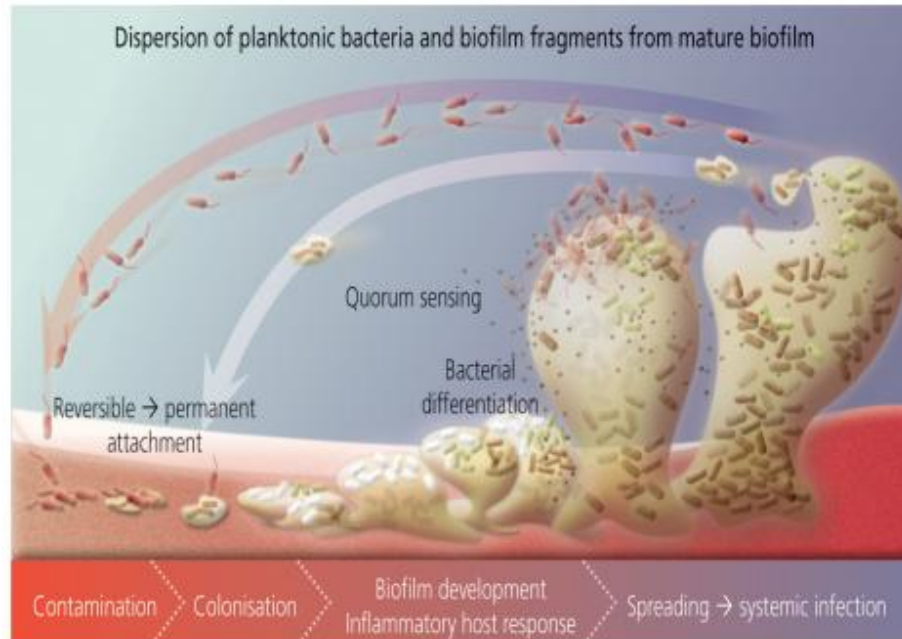
CATHETER SALVAGE

- Not just your basic “CVC insertion” – azygous, IVC, smaller vessels, tunneled on abdomen/non-conventional
- Vessel depletion – venous stenosis, multiple thromboses, compromised circulation
- IR, vascular surgery
- +/- anesthesia

The Triple Threat⁷



Biofilm – the matrix^{2,9,10}



**Biofilm =
#smartlime**

Strategies

- **Skin antisepsis** – targets site infection
- **Antiseptic cap** – targets infection (intraluminal, PROTECTIVE cover)

WHAT WE PUT IN THE LINES:

- **Taurolidine lock** – targets infection (intraluminal)
- **Heparin lock** – targets occlusion (anticoagulant)
- **T-EDTA lock** – targets infection, occlusion + biofilm

New strategy

Tetrasodium EDTA 4%

- Current patients: History of 2 or more CLABSI while on home TPN (“high risk”)
- Lock CVAD for approx. 8 hours/day (more if not on daily TPN)

What is EDTA?

Ethylene diamine tetra acetic acid

- Chemical used for industrial and medical purposes = anti-biofilm (eradicates and prevents)
- Amino-carboxylic acid that is colourless, water-soluble
- “Industrial” = i.e. keeps pipes/plumbing clean of biofilm; works against “hard water” (calcium++, chelates); common in shampoo, soap, cleaning agents; preservative / antioxidant in canned foods to prevent oxidation
- “Medical” = i.e. anticoagulant in lavender-top tubes for blood sampling (CBC-diff); chelation therapy for heavy metals (lead or aluminum toxicity)

CVAD Lock Solutions^{1-4,7-11}

Product	Anticoagulant	Antimicrobial	Antibiofilm (prevent)	Antibiofilm (eradicate)
Saline	X	X	X	X
Heparin	✓	X	X	X
Citrate 4%	✓	✓	✓	X
Citrate 4% w/ 30% ethanol	✓	✓	✓	X
Ethanol 70%	X	✓	✓	X
Antibiotic cocktail*	X	✓	✓	X
Taurolidine	X	✓	✓	X
CathFlo (tPA)	X	X	X	X
Tetrasodium EDTA 4%	✓	✓	✓	✓

Support in the literature^{2,9}

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DOI: 10.5301/jva.5000576

REVIEW

On EDTA: "... some advantages over antibiotic locks: no reported bacterial resistance, low industrial costs, ability to prevent catheter occlusion."

Evidence-based criteria for the choice of the most appropriate lock solutions for central venous catheters (excluding dialysis catheters): a GAVeCeLT consensus

Mauro Pittiruti¹, Sergio Bertoglio², Giancarlo Scoppettuolo¹, Roberto Biffi³, Massimo Lamperti⁴, Alberto Dal Molin⁵, Nicola Panocchia¹, Nicola Petrosillo⁶, Mario Venditti⁷, Carla Rigo⁸, Enrico DeLutio⁹

APMIS

ACTA PATHOLOGICA, MICROBIOLOGICA
ET IMMUNOLOGICA SCANDINAVICA

APMIS 125: 365-375

REVIEW ARTICLE

Central venous catheters: a European consensus stand in 2017.

MARIE GOMINET,^{1,2} FABRICE COMPAIN,^{2,3} CHRISTOPHE BELOIN⁴ and DAVID LEBEAUX^{1,2}

¹Service de Microbiologie, Unité Mobile de Microbiologie Clinique, Assistance Publique-Hôpitaux de Paris, Hôpital Européen Georges Pompidou, Paris; ²Université Paris Descartes, Paris; ³Service de Microbiologie, Assistance Publique-Hôpitaux de Paris, Hôpital Européen Georges Pompidou, Paris; and ⁴Unité de Génétique des Biofilms, Département de Microbiologie, Institut Pasteur, Paris, France

On biofilm eradication:
"Another strategy relies on the use of cation chelators (such as EDTA) that destabilizes the (biofilm) matrix."

Support in the literature³



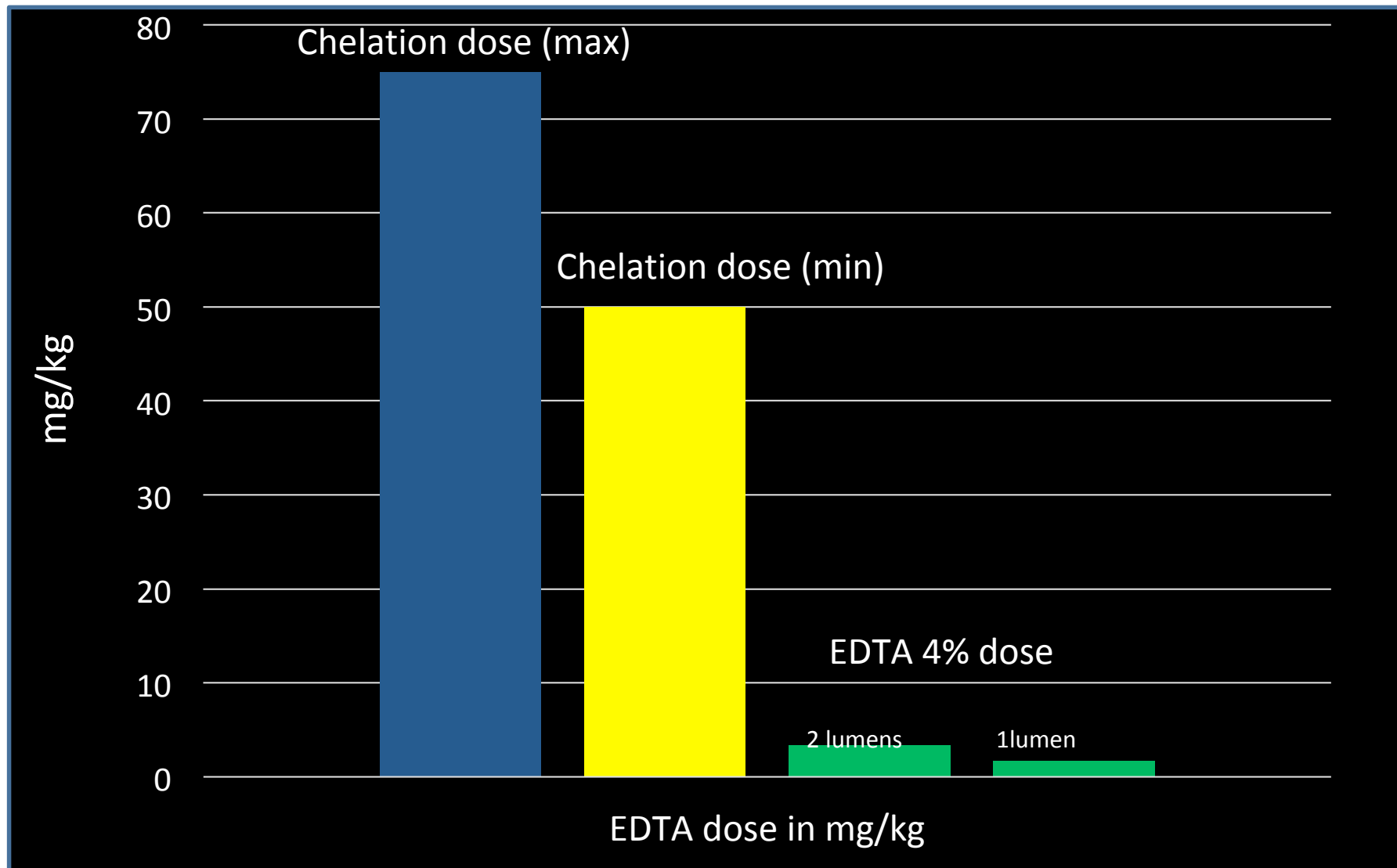
On CVAD locking for therapeutic and prophylactic purposes (for CLABSI): Use in patients with **long-term CVADs, patients with a history of multiple CRBSIs, high-risk patient populations...** (I)

Antiseptic locking solutions include ethanol, taurolidine, citrate, 26% sodium chloride, methylene blue, fusidic acid, and **ethylenediaminetetraacetic acid (EDTA)** used alone or in numerous combinations. (I)

What T-EDTA 4% strikes^{4,5,7}

Organism ID Gram negative	T-EDTA % conc.	Tri Sod.Citrate % conc.	Organism ID Gram positive	T-EDTA % conc.	Tri Sod.Citrate % conc.
68 Klebsiella	0.05	> 6	S24 Staph epidermidis	0.05	5
128 Klebsiella	0.05	> 6	31 Staph epidermidis	0.05	5
17 Klebsiella	2	> 6	301 Staph xylois	2	4
250 E.coli	1	> 6	300 Staph capitis	1	5
137 E.coli	0.05	> 6	J46 Staph lentis	0.05	6
292 Enterobacter	0.05	> 6	S24 Staph capitis	0.05	6
190 Enterobacter	0.1	> 6	R8 Staph simulans	0.1	3
J22 Enterobacter	0.05	> 6	72S Staph aureus	0.05	2
J20 Ps aeruginosa	0.8	> 6	R57 Staph aureus	0.8	>6
J26 Ps aeruginosa	0.05	> 6	S13 Staph aureus	0.05	5
177 Acinetobacter	0.05	> 6	R64 MRSA	0.05	6
J44 Acinetobacter	0.05	> 6	R51 MRSA	0.05	3
R16 Proteus mirabilis	1.5	> 6	R92 MRSA	0.05	>6
R81 Proteus vulgaris	0.8	> 6	S93 MRSA	0.05	2
R26 Proteus mirabilis	1.5	> 6	J67 MRSA	0.05	4

Safety Profile of T-EDTA 4% Sterile Catheter Lock Solution⁶



Outcomes so far

n= 23	HPN standard care Mean (range)	T-EDTA 4% mean (range)
Time on therapy	8.5 years (7mth-25 yrs)	12.3 mths (1-12.3mths)
# lines in past 12mths	19 (1-2)	2
# infections in past 12mths	16 (0-4)	7
# occlusions part 12mths (*required alteplase)	11 (0-4)	0
# inpatient days past 12mths	161 (0-90)	40 (3-37)
# patients on Swab Cap	11	23
# patients on Taurolidine	6	---

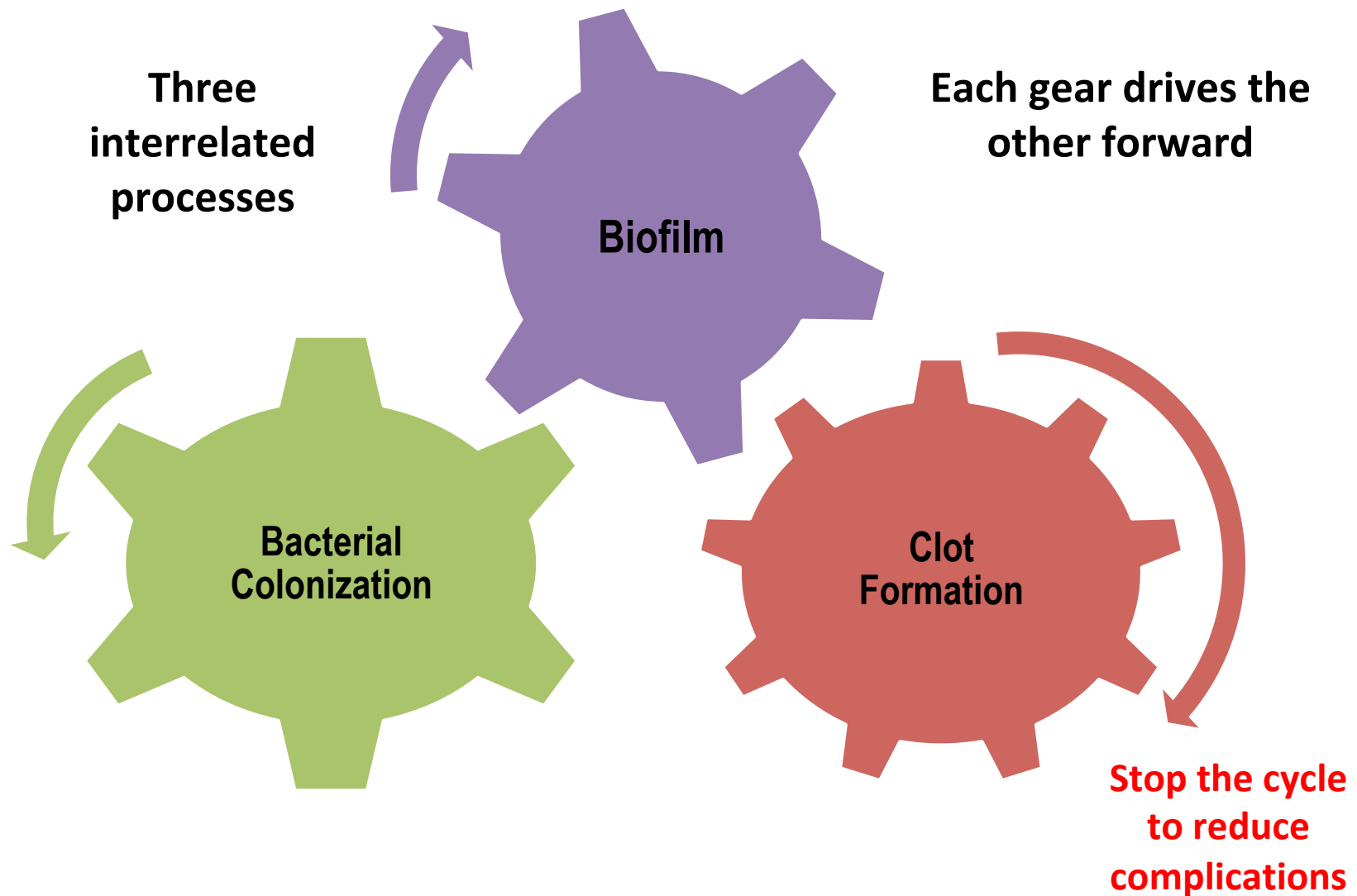
Outcomes so far

n= 23	Blood Culture Report
Female - Jan. 3 July 3	Staph aureus (exit site, skin only) Staph aureus
Female - Feb. 27	Wickerhamomyces anomalus Klebsiella pneumonia
Male - April 12 June 26	Enterobacter cloacae complex (peripheral only, CVC not removed) Esherichia hermanii, yeast, stenotrophomas maltophilia (CVC removed, replaced)
Male - July 13	Pseudomonas aeruginosa (exit site, skin only)
Female - July 25	Enterobacter cloacae Klebsiella oxytoca

Limitations

- **How sick they are** – chronic illnesses, high risk for infection (non TPN-related), other primary source of infection (MBI-LCBI)
- **Compliance, general hygiene**
- **Effect of strength and dexterity** –not available in pre-filled syringes currently
- **Use of other IV meds in CVADs** – multiple access

The Triple Threat⁷



Summary

- There is evidence to support the **strategy of T-EDTA 4% for a lock solution to combat the Triple Threat** of occlusion, bacterial colonization and biofilm formation .
- **Current results are promising** – data tracked prospectively on incidents of occlusion and infection, +/- intervention and removal/replacement of the CVAD.
- **T-EDTA 4% is useful for all patients with CVADs** – *bacteria does not make the differentiation between patients or types of CVADs*

*Vaccine and Infectious Disease Organization - International Vaccine Centre, Saskatoon, Saskatchewan, Canada
SterileCare Inc. 15 Allstate Parkway, Suite 600, Markham, Ontario Canada



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MATERIALS AND METHODS

Microbial isolates were obtained from either The Royal Family Hospital in Saskatoon, Saskatchewan (SK), representing western Canada, or catheter tips of patients from Southlake Regional Health Centre in Newmarket, Ontario (ON), representing eastern Canada. Minimum inhibitory and bactericidal concentrations (MICs and MBCs, respectively) of the PEDIA solution, against *G+* and *G-* bacterial strains and *C. albicans*, were determined using the microdilution method. The 6% PEDIA solution was then diluted in a 96-well plate in culture medium in 3-fold steps so that final concentrations ranged from 2% to 0.004%. After inoculation and growth for 24 h, turbidity of cultures in wells was measured by optical density (OD_{600}) against uninoculated wells, and MIC values were determined by comparing to controls. Cultures from wells at optical densities higher and lower than MIC values were examined for viable bacterial cells. MICs and MBCs were determined by serial dilution and plating.

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

The objective of this study was to demonstrate the efficacy of a novel catheter lock solution of 4% tetrasodium ethylenediamine tetracetate (T-EDTA), approved as a Class II medical device in Canada to eradicate current and clinically relevant microorganisms and associated biofilms obtained from Canadian hospitals.

The multifactorial mechanisms of action of T-EDTA in killing microbes and inhibiting and eradicating biofilm primarily involve its metal-chelating activity. All bacterial strains (planktonic and sessile) tested in this study were killed at concentrations ≥ 40 mg/mL, 4% after a standard 24-hour exposure including antibiotic resistant bacteria and associated biofilms (MRSA and VRE). A review of the literature revealed a poor linear correlation between catheter colonization and CLASP[®], thereby supporting the importance of reducing bacterial colonization and biofilm formation on catheters. The use of T-EDTA against bacteria such as MRSA and VRE. The 4% T-EDTA lock solution is unique in that it is antibiotic, ethanol- and preservative-free with a wide margin of safety, and demonstrated compatibility with all polyurethanes and silicone CVDs as well as effectiveness against clinically relevant Gram- and Gram-negative bacteria. Routine use of an effective solution against the 'Triple Threat' of clot, bacteria and biofilms such as this solution may reduce the risk of catheter-associated infections and the risk of bacterial colonization and biofilm formation within CVDs. It is crucial in reducing the risk of CLASP[®] within Canadian hospitals.

Figure 1 consists of two bar charts, (a) and (b), showing the effect of 100 mg/kg BW of 17β-OH progesterone on sperm parameters. The y-axis for both charts is 'Number' ranging from 0 to 10. The x-axis for both charts is 'Group' with four categories: Control, Progesterone, Progesterone + Vitamin E, and Progesterone + Vitamin E + Selenium.

Chart (a) shows the number of spermatozoa in the epididymus. The Control group has the highest number (approx. 9.5), followed by Progesterone + Vitamin E + Selenium (approx. 8.5), Progesterone + Vitamin E (approx. 7.5), and Progesterone (approx. 6.5). The Progesterone group is significantly lower than the Control group (p < 0.05).

Chart (b) shows the number of spermatozoa in the spermatozoal suspension. The Control group has the highest number (approx. 9.5), followed by Progesterone + Vitamin E + Selenium (approx. 8.5), Progesterone + Vitamin E (approx. 7.5), and Progesterone (approx. 6.5). The Progesterone group is significantly lower than the Control group (p < 0.05).

Variable	1990	1991	1992	1993	1994	1995
Population	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Population aged 15 and over	750,000	750,000	750,000	750,000	750,000	750,000
Population aged 15 and over, female	375,000	375,000	375,000	375,000	375,000	375,000
Population aged 15 and over, male	375,000	375,000	375,000	375,000	375,000	375,000
Population aged 15 and over, non-white	150,000	150,000	150,000	150,000	150,000	150,000
Population aged 15 and over, white	600,000	600,000	600,000	600,000	600,000	600,000
Population aged 15 and over, black	100,000	100,000	100,000	100,000	100,000	100,000
Population aged 15 and over, other	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, non-white, female	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, non-white, male	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, white, female	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, white, male	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, black, female	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, black, male	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, other, female	25,000	25,000	25,000	25,000	25,000	25,000
Population aged 15 and over, other, male	25,000	25,000	25,000	25,000	25,000	25,000
Population aged 15 and over, non-white, female, non-white	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, non-white, female, white	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, non-white, male, non-white	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, non-white, male, white	75,000	75,000	75,000	75,000	75,000	75,000
Population aged 15 and over, white, female, non-white	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, white, female, white	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, white, male, non-white	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, white, male, white	300,000	300,000	300,000	300,000	300,000	300,000
Population aged 15 and over, black, female, non-white	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, black, female, white	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, black, male, non-white	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, black, male, white	50,000	50,000	50,000	50,000	50,000	50,000
Population aged 15 and over, other, female, non-white	25,000	25,000	25,000	25,000	25,000	25,000
Population aged 15 and over, other, female, white	25,000	25,000	25,000	25,000	25,000	25,000
Population aged 15 and over, other, male, non-white	25,000	25,000	25,000	25,000	25,000	25,000
Population aged 15 and over, other, male, white	25,000	25,000	25,000	25,000	25,000	25,000

Source: U.S. Census Bureau, 1990 Census of Population and Housing, Summary File 1, Table 100.

Figure 1 consists of two bar charts side-by-side. The left chart is titled 'COVID-19' and the right chart is titled 'Dengue'. Both charts have 'Cases' on the y-axis and 'Year' on the x-axis. The y-axis for both charts ranges from 0 to 100,000. The x-axis for both charts has three categories: 2020, 2021, and 2022. In the COVID-19 chart, the bars for 2020 and 2021 are very low, near zero, while the bar for 2022 is significantly higher, around 10,000. In the Dengue chart, the bars for 2020 and 2021 are also very low, near zero, while the bar for 2022 is significantly higher, around 10,000.



Figure 2. Time to kill assay of 4% T-EDTA bulk solution against clinically relevant *G.* and *C.* isolates obtained from Canadian hospitals. The $\square$ indicates a statistically significant difference ($P < 0.05$).

- **Antimicrobial stewardship** is the responsible use of antimicrobials to optimize clinical outcomes, reduce resistance, and minimize toxicity.
- **Antimicrobial stewardship programs** are multidisciplinary teams that coordinate the use of antimicrobials in a hospital or community setting.
- **Antimicrobial stewardship programs** aim to:

 - **Identify and reduce inappropriate use of antimicrobials.**
 - **Optimize the selection, dosing, and duration of antimicrobial therapy.**
 - **Monitor and report on antimicrobial use and resistance.**
 - **Educate healthcare providers and patients on the appropriate use of antimicrobials.**

[illegible]

陳國華電機研究所

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CONTACT INFORMATION

Dr. Crystal Liguori: cliguori@enterlangua.com





jocelyngrecia@hotmail.com

THANK YOU

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