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Going with the flow or swimming against the tide: Should children with central venous catheters be allowed to go swimming?

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Introduction

Swimming is one of the most popular sports activities for children in the United States. It is not only enjoyable, but it is also an excellent form of aerobic physical activity. Many consider recreational swimming to be a common part of childhood, but for some, the risk may outweigh the benefit. Children who require long-term parenteral nutrition (PN) support have central venous catheters (CVCs) in place to provide life-sustaining fluid, nutrients, and medications. Children with CVCs, however, may be at increased risk of exit site, tunnel, and catheter related bloodstream infections (CRBSIs) resulting from water submersion as may happen with swimming. The purpose of this review is to evaluate the current literature regarding the risk of infection for patients with CVCs who swim recreationally, and determine if there is consensus among home PN programs on this controversial issue.

Methods

A literature search was performed using PubMed, databases of the English literature, Google, and EMBASE for relevant articles published from 1995 to 2013. Search terms included: swimming, recreational water, central venous catheter, bacteria, virus, pathogen, infection, and outbreak. Titles and abstracts were reviewed for content regarding the risk of infection in patients with central venous catheters who swim. Due to the paucity of literature in this specific patient population, the search also included publications on recreational water (i.e., oceans, pools, lakes, ponds) outbreaks in the United States in all patient populations as well as publications regarding specific human pathogens that can be found in recreational water that may pose a risk to swimmers.

The literature was analyzed and graded according to the quality of the evidence available. The concepts of the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) working group (<http://www.gradeworkinggroup.org>) for development of its clinical guidelines were utilized. This method combines the efforts of evidence analysis methodologists and clinical guideline developers from a variety of practice areas resulting in a transparent method of evaluating the best evidence.¹ As part of the literature search, each relevant paper was appraised for the quality of evidence according to research quality (attrition, bias, blinding, randomization, sample size, and study design) and placed into an evidence table (Tables 1–3).

We also determined the practices of home parenteral nutrition (HPN) programs in the United States regarding this controversial question. HPN programs were identified through the Oley Foundation website (http://oley.org/medical_expertise.html). Oley is a national, independent organization that provides education, outreach, and networking for patients (and their caregivers/clinicians) dependent on HPN and tube feeding. A total of 25 HPN programs were identified. Each program was contacted via email and asked three questions: 1) Do you allow your patients with central venous catheters to go swimming? If yes, what bodies of water are allowed (ocean, lake, pool, etc.)? 2) Are your patients required to use dressings/coverings? If yes, which product(s)? 3) Are there any other rules that the patients must follow? The responses were de-identified and documented (Table 4).

Results

A total of 45 papers were identified. Twenty three clinical studies were considered for review, consisting of 16 retrospective studies, 6 case control studies, and 1 review article. Tables 1–3 summarize these findings.

Robbins et al.², were the only group to explicitly study the increased risk of CRBSIs in children with in-dwelling catheters. This descriptive study utilized a self-report questionnaire completed by parents of patients along with a retrospective chart review. A total of 91 children with cancer and in-dwelling CVCs were included, of whom 49 were swimmers and 46 were non-swimmers (four children had two catheters and swam with one catheter but not the other; therefore, these children were accounted for twice). There were 34 catheter-related infections in the swimming group compared to 13 in the non-swimming

group; this difference, however, was not concluded by the authors to be statistically significant when adjusted for number of infections per catheter month. A separate chi square analysis, however, shows that this difference of 34/49 vs. 13/46 patients is highly significant ($p < 0.0001$) when the duration of catheter is not taken into consideration. Although this study did not conclude an increased risk of catheter-related infections amongst patients with in-dwelling catheters who did swim, there were several limitations. First, this was a retrospective study, and swimming was determined by a self-report questionnaire. Second, because the group could not collect accurate data regarding the dates that the patients went swimming, they were not able to distinguish whether infections had occurred before or after the patients engaged in this recreational activity. Lastly, the authors took into account the duration of catheter instead of focusing on the exposure of catheter to recreational water, which is the true question being studied.

Similarly Smith et al³ retrospectively evaluated the perceived increased risk of CRBSIs in pediatric hematology–oncology patients with CVCs and found that no significant increase in CRBSI rates. The authors did, however, report a statistically significant increase in non-endogenous, gram-negative infections (e.g., *Pseudomonas* species) during summer months (May–October) in comparison to the rest of the year. The self-reported summertime recreational water exposures were similar and high in the two groups, but it is important to note that this study was also a retrospective analysis and relied on parents to recall exposure to recreational water (Table 1). In the aforementioned study by Robbins et al., summer infections were also higher in the swimmer group vs. non-swimmer group (15/49 vs. 6/46; $p < 0.05$).

The remaining literature reviewed demonstrated the abundance of human pathogens that have caused outbreaks in the general population in all types of recreational water including lakes, oceans, public swimming pools, water parks, etc. (Tables 2–3). Human pathogens that have been identified as etiologic agents involved with recreational water outbreaks include *Escherichia coli*, *Pseudomonas*, *Cryptosporidium*, *Norovirus*, *Shigella*, *Giardia*, and *Enterococci* and have resulted in primarily gastrointestinal infections.^{4–18} These findings suggest that such environments may not be optimal for patients with CVCs, and that controlled environments such as private swimming pools may theoretically minimize the risk of catheter-related infections in patients choosing to swim. Interestingly, the Parenteral Nutrition Guidelines Working Group, European Society for Clinical Nutrition and Metabolism; European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN); European Society of Paediatric Research (ESPR); and European Society for Parenteral and Enteral Nutrition (ESPEN), based on the aforementioned Robbins et al. paper, do not consider “catheter submerging” as a risk factor for increased catheter-related infections in children with tunneled catheters. The guidelines’ authors, however, considered the level of evidence (LOE) according to the Scottish Intercollegiate Guideline Network (SIGN) 2000 to be only LOE 2 (i.e., case control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal). Moreover, these same guidelines also state: “With tunneled catheters, swimming is possible if the catheter is secured with water resistant dressing,” and assign a grade of LOE 4 (i.e.,

evidence from expert opinion). The quality of the actual swimming environment was not addressed by the guidelines.¹⁹

In regards to the survey of HPN programs, 16 of the 25 HPN programs identified (64%) responded to the questions posed via email. Three programs (19%) only allowed their patients with un-accessed ports that were well healed to go swimming; five programs (31%) allowed patients to go swimming with un-accessed ports or tunneled catheters (Hickman[®], Broviac[®]); two programs (12.5%) allowed patients to go swimming with cuffed peripherally inserted central catheters (i.e., PICCs); one program (6%) allowed swimming without restrictions; and two programs (12.5 %) allowed “minimal swimming” but did not specify a restriction on the type of lines nor what “minimal swimming” entailed. Three programs (19%) did not allow any swimming of any sort; one program (6%) did not allow infants to go in the water, but did allow older patients to swim; and one program (6%) had not had this situation come up. For the programs that did allow swimming, two programs (12.5%) allowed any body of water; two programs (12.5%) allowed oceans or pools; 1 (6 %) program allowed oceans, pools, and private hot tubs; six programs (38%) only allowed pools; and one program (6%) did not specify. Dressing or line covers varied among the programs and there was no consistency in the products recommended, but Tegaderm[®] and AquaGuard[®] were both mentioned. All programs that allowed their patients to go swimming recommended cleaning the site and changing the dressing immediately after swimming.

Discussion

Despite the growing number of children with CVCs, the risk of infection after swimming has not been well studied. There is currently no strong evidence concluding that swimming has caused an increase in catheter-related infections; however, there is also no evidence to suggest that this is a safe practice in this patient population. Our own interest in the topic arose after a child with intestinal failure we cared for suffered a fatal *pseudomonas* CVC infection within 24 hours of swimming in the ocean.

A report from the Centers for Disease Control and Prevention documented a total of 134 recreational water-associated outbreaks from 38 states and Puerto Rico in a two-year period, which resulted in 13,966 cases in the general population. A total of 116 (86.6%) of the outbreaks were associated with treated recreational water (e.g., swimming pools).¹⁸ This report indicates that swimming is not a completely safe activity for the general public, let alone patients with a CVC who are already at great risk of acquiring a serious infection. It is generally accepted that lakes and ponds, which are stagnant in nature, will more than likely be contaminated with fecal matter from birds, ducks, geese, etc.²² However, there is also supporting literature demonstrating the presence of human pathogens in the ocean as well as chlorinated pools, such as methicillin resistant *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Cryptosporidium*, *Enterococci*, as well as viruses (adenovirus, norovirus, echovirus, hepatitis A virus, coxsackieviruses), which can cause significant morbidity and mortality when given direct access to the bloodstream.^{3–18} Proper maintenance of recreational water may play an important role in minimizing outbreaks, as it has been shown that many are in violation.^{6–7,10–12,15,18,20–21} Despite this knowledge, recreational water outbreaks continue to be reported. In addition, it is important to note that

while arguments exist that private pools are perceived to have lower risks of infection, there is also less data reported with private pools as they are generally considered isolated infections. The actual risk of any recreational water environment remains unknown.

Detection of *E. coli* found in many recreational water areas indicates that swimmers often introduce fecal matter into pool areas where the pathogen can easily be transmitted to others. Similar to swimmers, other warm-blooded animals can also introduce *E. coli* in the same manner. In addition, *P. aeruginosa* has been found in contaminated pools where it often inhabits biofilms on moist surfaces, especially pool walls and filters.^{3–18, 27} These factors coupled with potential host immunosuppression can place patients at increased risk of acquiring catheter-related infections. One might postulate that exit site or tunneled infections would be common vs. CRBSIs due to direct access of the site with the contaminated environment, especially if the catheter site is not yet healed; studies, however, have not been sufficient to conclude a direct correlation.²

Parents looking for guidance as they struggle with the decision of whether they should allow their child to go swimming could visit the Oley Foundation website as well as various online patient maintained blogs. The Oley Foundation states that there is no evidence that swimming has caused a CRBSI, and therefore many HPN programs allow their patients with CVCs to swim once the site is healed, as long as it is 30 days after line placement. The Oley Foundation also states that the ocean and private pools are normally safe, but lakes, ponds, and hot tubs should be avoided. They also advise performing site care immediately after swimming (i.e., dressing changes) and recommend several products such as AquaGuard®, Dry Pro PICC®, XeroSox®, Tegaderm®, or OpSite® that may be used for protecting catheter sites.²² These online blogs, however, send mixed messages, as some parents have had good success with the aforementioned products and have allowed their child to swim while others are not willing to take the risk. The CDC's Healthy Swimming Program and website (<http://www.cdc.gov/healthywater/swimming>), launched in 2001, provides information for the public, public health and medical professionals, and aquatics staff on how to minimize risks and maintaining sanitary swimming conditions.²⁸ Additional links to state-specific Healthy Swimming resources, such as, beach monitoring, water quality programs, facts on recreational water illnesses, pool code information and contacts to local public health authorities are also provided.

A survey of HPN programs across the country, including both pediatric and adult patients, was also not consistent. Most programs only allowed well-maintained, chlorinated, private pools, however, some programs allowed their patients to swim in the ocean as well. There was no consistency in the dressings or products recommended, but Tegaderm® and AquaGuard® were both mentioned. For the programs that did allow their patients to go swimming, there was a unified consensus in the recommendation to clean the site and change the dressing immediately after swimming.

Conclusion

The decision to allow children with CVCs to go swimming is one wrought with mixed messages and little evidence. Unfortunately, due to the limited information available, a firm

recommendation cannot be made. Recreational water associated outbreaks are well documented in the general public as is the presence of human pathogens even in chlorinated swimming pools. As a medical team, practitioners can provide information regarding the potential risk, but ultimately the decision lies with the parents. Due to our experience with a fatal event immediately after swimming, we continue to strongly discourage patients with central venous catheters from swimming. Moreover, if the parents decide engaging in this popular pastime is still worth the risk, they are encouraged to ensure proper line/site maintenance and to use products which are specifically designed for this use that may mitigate infection risk. Further studies regarding the risk of swimming with a CVC are needed to make a strong, evidence-based recommendation.

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Table 1
Previous Studies Detailing CVC-Related Infections and Recreational Water Exposure

Author, Year	Study Design	Population, Setting, N	Study Objective	Results	Comments	GRADE of evidence for outcome																
Robbins ² , 1999	Descriptive study Self-report (parents) questionnaire & review of medical records	Children with cancer & single or double-lumen Broviac or Hickman catheters Children's Hospital @ Strong, Rochester, New York N = 91 patients, 101 catheters	Determine whether pediatric oncology patients who swim with in-dwelling catheters are at increased risk of catheter related infections	<table><tr><td></td><td>Infections</td><td>No infections</td><td>Total</td></tr><tr><td>Swimmers</td><td>34</td><td>15</td><td>49</td></tr><tr><td>Non-Swimmers</td><td>13</td><td>33</td><td>46</td></tr><tr><td>Total</td><td>47</td><td>48</td><td>95</td></tr></table> <p>Chi-square = 16.054 Degrees of freedom = 1 p-value = 0.00006156</p>		Infections	No infections	Total	Swimmers	34	15	49	Non-Swimmers	13	33	46	Total	47	48	95	Swimming determined by self-report questionnaire Moderate sample size	Low
	Infections	No infections	Total																			
Swimmers	34	15	49																			
Non-Swimmers	13	33	46																			
Total	47	48	95																			
Smith ³ , 2002	Retrospective, case-control study	Pediatric hematology-oncology clinic outpatients w/CVCs Fresno Children's Hospital, Fresno, California N = 25 cases (CVC-assoc. BSI), 25 controls (CVC)	Investigate a perceived increase in CVC-associated bloodstream infections (BSIs) among pediatric hematology-oncology outpatients	<p>25 case patients has 42 CVC-associated BSIs No significant increase in CVC-associated BSI rates occurred among pediatric hematology-oncology patients Statistically significant increase in non-endogenous, gram-negative (e.g., <i>Pseudomonas</i> species) during summer months (May-October) compared to the rest of the year Summertime recreational water exposures were similar and high in the 2 groups</p>	Recreational water exposure was determine by survey and only 34 of the 50 patients returned the survey Moderate sample size	Low																

Table 2
Previous Studies Detailing Infectious Outbreaks Associated with Recreational Water

Author, Year	Study Design	Population, Setting, N	Study Objective	Results	Comments	GRADE of evidence for outcome
Kuo ⁴ , 1995	2 case control studies	Children & adults who visited Rockford, Illinois state park during June 24 – July 1 N1 = 7 cases, 7 controls N2 = 10 cases, 20 controls	Assess risk factors for illness and determine the source of infection after an <i>E. coli</i> 0157:H7 outbreak	12 initial cases were identified, 7 culture-confirmed <i>E. coli</i> 0157:H7 (1 HUS), & 1 culture-negative bloody diarrhea 1) Matched analysis of case-patients and controls indicated that swimming at Rockford, Illinois state park lake was the only risk factor for illness, OR = undefined; 95% CI = 4.0 - undefined 2) Analysis by unmatched odds ratios suggested that risk for illness was associated with taking lake water into the mouth (OR = 9.8, 95% CI = 1.03–93.5) & swallowing lake water (OR = 12.4, 95% CI = 1.3 – 118.3)	<i>E. coli</i> 0157:H7 was not isolated from lake water Lake exposure & history was determined by questionnaire Moderate sample size	Low
Ackman ⁵ , 1997	Case control study	Children & adults who visited a multi-use park in northern Dutchess County, New York N = 12 cases (symptomatic person w/stool culture + for <i>E. coli</i> 0157:H7) & 36 controls	Determine the extent of the <i>E. coli</i> 0157:H7 outbreak and identify the source of infection	All of the case-patients & 35 (97%) of the control patients swam in the lake There was no association between infection and time spent in the water or swimming Case patients were more likely than controls to have swallowed lake water; however, this was not statistically significant None of the case-patients ate at the same restaurant	<i>E. coli</i> 0157:H7 was not isolated from suspected water Lake exposure & history was determined by survey Moderate sample size	Low
Friedman ⁶ , 1999	Surveillance study	Children & adults who attended a Fourth of July party at a semi-commercial trailer park/recreational center as well as residents of the park in rural Georgia	Determine the extent of the <i>E. coli</i> 0157:H7 outbreak and the source of the infection	Of 51 party attendees and trailer park resident, 18 developed a GI illness (12 positive culture or titers) Swimming in the pool significantly increased the risk of illness (RR = 6.3; 95% CI = 1.8 – 18.9) No other exposure was significantly associated with illness	<i>E. coli</i> 0157:H7 was not isolated from suspected water The implicated pool had little to no chlorine added during the period of the outbreak Moderate sample size	Low
Beckett ⁷ , 2000	Observational report (Colorado) & Case control study (Maine)	Children & adults affected by outbreaks of <i>Pseudomonas</i> dermatitis/folliculitis associated with pools & hot tubs in Colorado & Maine in 1999 – 2000 N (Colorado) = 22 persons N (Maine) = 9 cases, 25 controls	Summarize these outbreaks of <i>Pseudomonas</i> folliculitis and identify the primary risk factors for infection	Colorado: 22 community residents who used the pool and/or hot tub in question from February 5–7 were interviewed 20 persons used the hot tub & 19 (95%) developed a rash & 14 (74%) has more severe illness (rash 2 wks + 1 other symptom) * 1 tested positive for <i>Pseudomonas</i> *	Specimens collected during inspection from hot tub & pool filters were + <i>Pseudomonas aeruginosa</i> Pool & hot tub exposure determined by phone interview Chlorine levels in both the pool & hot tub were < 1	Low

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Author, Year	Study Design	Population, Setting, N	Study Objective	Results	Comments	GRADE of evidence for outcome
Causer ¹⁴ , 2006	Descriptive study & case control study	Children & adults who visited a recreational water park in Illinois from July 1 to August 31, 2001 N = 358 case patients N = 50 case patients, 50 matched controls	Report an outbreak of <i>Cryptosporidium</i> and identify potential sources of the outbreak	Increased risk was associated increased exposure to lake water ($p = 0.01$) and those who reported getting water from the lake Increased risk was associated increased exposure to lake water ($p = 0.01$) and those who reported getting water from the lake Increased risk was associated increased exposure to lake water ($p = 0.01$) and those who reported getting water from the lake 358 case patients were identified, 281 clinical cases; person living in or visiting central Illinois between July 1–Aug 31 w/ 1 day w/ 3 loose or watery stools/24h 77 lab confirmed cases; person living in or visiting central Illinois between July 1–Aug 31 w/a positive <i>Cryptosporidium</i> stool test and at least 1 symptom Case patients were primarily children < 18 yrs (77.9%) Swimming at the water park was strongly associated with cryptosporidiosis (OR = 16, 95% CI = 3.8–66.8)	<i>Cryptosporidium</i> oocysts were isolated from the toddler/wading pool Information regarding exposures were collected through phone interviews Moderate sample size	Low
Katz ¹⁵ , 2006	Retrospective cohort study	All country-club member households	Determine the source of an outbreak of giardiasis affecting families belonging to a country club in a suburb of Boston, Massachusetts	Giardiasis-compatible illness was experienced by 149 (25%) of respondents to a questionnaire 97 (65%) were lab confirmed cases Of the 30 primary cases, exposure to a children's pool at the country club was significantly associated with illness (RR = 3.3, 95% CI = 1.7–6.5) 105 secondary cases probably resulted from person-person contact 14 cases did not report onset date	Information regarding exposures were collected through questionnaires Moderate sample size	Low
Jue ¹⁶ , 2009	Descriptive study	Children & adults who visited a splash park in Idaho from July 23 – Aug 10, 2007 N = 154 respondents	Summarize the investigation of the cryptosporidiosis outbreak	Among 154 respondents surveyed, 5 confirmed & 45 clinically compatible cases of cryptosporidiosis were identified (32% attack rate) Patients were more likely than non-ill park visitors to have been exposed to water from a splash feature (RR = 4.7)	Water samples collected from splash features and adjacent drinking fountain tested positive for <i>Cryptosporidium hominis</i> Information regarding exposures were collected through phone interviews Moderate sample size	Low
Sinclair ¹⁷ , 2009	Review article	ALL viral disease outbreaks reported from recreational water	Obtain the most information possible about recreational water-borne viral disease outbreaks	Norovirus are believed to be the single largest cause of recreationally water-born viral disease outbreak (45% in published literature) Other documented viral outbreaks from adenovirus (24%), echovirus (18%), hepatitis A virus (7%), coxsackieviruses (5%)	51% of outbreaks were reported to primarily affect children, 24% all ages, 25% unknown Children are disproportionately affected by water-borne recreational outbreaks in this review	Moderate

Author, Year	Study Design	Population, Setting, N	Study Objective	Results	Comments	GRADE of evidence for outcome
				49% of outbreaks occurred in swimming pools and 40% occurred in lakes or ponds 49% of outbreaks occurred in swimming pools and 40% occurred in lakes or ponds Inadequate disinfection was related to 69% of swimming pool outbreaks		
Gregg ²³ , 2010	Surveillance study	25 samples of MRSA inoculated fluid (~96,357 organisms/mL) were placed in 3 types of pool water: chlorinated, saltwater, and biguanide Baquacil	Examine the viability of methicillin-resistant <i>Staphylococcus aureus</i> (MRSA) in 3 types of swimming pool environments	No MRSA growth was found in any of the water samples after 1 hour of exposure using dilutions of 0.5 and 1 McFarland standard MRSA was found only in chlorinated water samples after 30 minutes in quantities of 13600 CFU/mL, 2300 CFU/mL, 4100 CFU/mL	Chlorine diminished MRSA growth significantly at 30 minutes and eliminated viable MRSA at 1 hour	Low
Graczyk ²⁴ , 2010	Surveillance study	Water samples were collected during 11 consecutive summer weeks over July, August, September Chesapeake Bay, MD	Determine relationships among bathers, density, levels of human waterborne pathogens, and Enterococci counts in marine recreational beach water	# of bathers on weekends was significantly higher than on weekdays ($p < 0.001$) & this was associated with increased water turbidity ($p < 0.04$) Proportion of water samples containing <i>Cryptosporidium parvum</i> , <i>Giardia duodenalis</i> , and <i>Enterocytozoon bieneusi</i> was significantly higher ($p < 0.03$) & concentration of pathogens was significantly higher ($p < 0.04$) on weekends than weekdays <i>Enterococci</i> was also significantly higher on weekends ($p = 0.001$) and was higher than U.S. EPA limit in 18 of 27 (67%) weekend samples	Human pathogens were found in marine samples in higher concentrations on weekends than weekdays and was correlated with the # of bathers present	Low
Capello ²⁰ , 2011	Surveillance study	Water samples from 27 public chlorinated swimming facilities in a Colorado metropolitan community during the 2008 summer swimming season	Assess bacteriological contamination of local public swimming facilities and determine if routine bacteriological samples may be warranted	27 chlorinated public swimming facilities were sampled twice within 2 consecutive weeks for total coliform, fecal coliform, and heterotrophic plate count bacteria 11% of the public swimming facilities were in excess of public health standards for total coliform bacteria 18.5% of the public swimming facilities were in excess of public health standards for total bacteria count	Total coliform bacteria tests are commonly used as a general indicator of bacteriological contamination Contamination was likely caused by inadequate water treatment operations	Low
Lutz ²⁵ , 2011	Surveillance study	108 samples obtained from 3 hot tubs & 8 indoor swimming pools	Determine the background prevalence and antimicrobial resistance profile of <i>P. aeruginosa</i> in swimming pools and hot tubs	23 samples (21%) were positive for <i>Pseudomonas aeruginosa</i> 23 isolates underwent susceptibility testing and resistance was noted to amikacin, aztreonam, ceftriaxone, gentamicin, imipenem, meropenem, ticarcillin/clavulanic acid, tobramycin, and trimethoprim/sulfamethoxazole	<i>P. aeruginosa</i> contamination was common in swimming pools and hot tubs, even where chlorine concentrations are well above recommended levels	Low

Author, Year	Study Design	Population, Setting, N	Study Objective	Results	Comments	GRADE of evidence for outcome
				96% of <i>P. aeruginosa</i> isolates tested from swimming pools and hot tubs were multidrug resistant isolates tested from swimming pools and hot tubs were multidrug resistant	swimming pools and hot tubs were multidrug resistant	Miller et al. ²⁶
McCann ²⁶ 2013.	Cohort study	Members of a swimming club with probable case of illness filled out questionnaires on exposure to swimming and nature of illness	Identify the number of swimmers affected and risk factors for infection	48 cases of probably infection and 53-nocases were recruited. Multivariate analysis demonstrated a strong and highly significant association between illness and attendance at a training session on a specific date. Median duration of illness was 3 days	Pool water was not sampled for <i>Cryptosporidium</i> , however, there were confirmed patient samples linked to pool attendance.	Low
Hutcheson ²⁷ 2013	Surveillance study	161 filter backwash samples collected	Assess contamination of public swimming pools in metro-Atlantic area and determine what pathogens are introduced through recreational water	<i>E. coli</i> was detected in 93 (58%) of 161 samples collected. <i>P. aeruginosa</i> was detected in 95 (59%) samples. Both pathogens were detected in 67 (42%) samples. <i>Giardia intestinalis</i> was detected in two samples. <i>Cryptosporidium</i> ssp. were detected in one sample.	<i>P. aeruginosa</i> and <i>E. coli</i> contamination was present in more than half of the filter samples, indicating that swimmers frequently introduce pathogens into pools and may transmit pathogens to others through recreational water.	Low

* Recreational waters include: swimming and wading pools, fresh and marine waters, water parks, interactive fountains, and thermal or other natural springs*

Table 3

CDC Studies Detailing Infectious Outbreaks Associated with Recreational Water

Author, Year	Study Design	Population	Study Objective	Results	Comments	GRADE of evidence for outcome
Yoder ¹⁰ 2004	Observational report	Waterborne disease outbreaks in the U.S. associated with recreational water that occurred during January 2001–December 2002	Summarize recreational water-associated outbreaks	A total of 65 recreational water-associated outbreaks were reported by 23 states and resulted in 2,536 cases. 44 (67.7%) outbreaks were associated with treated recreational water (e.g. pools). 30 outbreaks (46.2%) were acute gastrointestinal illness, 21 (32.3%) were dermatologic illnesses, 8 (12.3%) were meningoencephalitis, and 6 (9.2%) were acute respiratory illness. Etiology agent was identified or suspected in 53 (81.5%) of the outbreaks: 27 (41.5%) bacteria, 21 (32.3%) parasites, 8 (12.3%) unknown, 5 (7.6%) viruses, 4 (6.2%) chemical. <i>Pseudomonas</i> , the leading etiologic agent, was confirmed as the etiologic agent in 18 (27.6%) of the 65 outbreaks followed by <i>Cryptosporidium</i> in 11 (16.9%) of cases.		Low
Craun ¹² 2005	Observational report	Reported outbreaks associated with recreational water during 1971–2000 in the United States	Review the causes of outbreaks associated with recreational water	A total of 259 recreational water-associated outbreaks were reported and resulted in 21,740 cases. 75% of outbreaks had a bacterial (37.5%) or protozoan (37.5%) etiology. 15.4% of outbreaks were of undetermined etiology. 6.9% of outbreaks had a viral etiology. Most frequently identified agents: <i>Cryptosporidium</i> (15%), <i>Pseudomonas</i> (14%), <i>Shigella</i> (13%), <i>Naegleria</i> (11%), <i>Giardia</i> (6%), toxigenic <i>E. coli</i> (6%).	<i>Shigella</i> , <i>E. coli</i> 0157:H7, and <i>Naegleria</i> were primarily associated with fresh water (lakes, ponds, rivers). <i>Cryptosporidium</i> and <i>Giardia</i> were associated with treated water (swimming pools). Contamination was due to the bathers, sewage discharges, and wild or domestic animals, as well as inadequate maintenance.	Low
Hlavsa ¹⁸ 2011	Observational report	Waterborne disease outbreaks in the U.S. associated with recreational water that occurred during January 2007–December 2008	Summarize recreational water-associated outbreaks	A total of 134 recreational water-associated outbreaks were reported by 38 states and Puerto Rico and resulted in 13,966 cases. 116 (86.6%) outbreaks were associated with treated recreational water (e.g. pools) and resulted in 13,480 cases. 81 outbreaks (60.4%) were acute gastrointestinal illness, 24 (17.9%) were outbreaks of dermatologic illnesses, and 17 (12.7%) were acute respiratory illness. Etiology agent was confirmed in 105 (88.4%) of the outbreaks: 68 (64.8%) parasites, 22 (21%) bacteria, 5 (4.8%) viruses, 9 (8.6%) chemical/toxins, 1 (1%) multiple etiology types. <i>Cryptosporidium</i> , the leading etiologic agent, 60 (44.8%) of the 134 outbreaks.	This represented a substantial increase in the number of outbreaks as compared to 2005–2006 (78 outbreaks).	Low

Survey of Swimming Practices among Home Parenteral Nutrition Programs in the United States

Table 4

HPN Program	Do you allow your patients to swim with a CVC?	Bodies of water allowed	Dressing/PICC line covers	Other rules
A	Tunneled catheters > 2 mos. post placement Un-accessed ports	Ocean Pool	Transparent dressing over catheter Ports: needle must be out for 4 hrs prior to swimming	Clean site and change dressing immediately after water activity
B	Only mediports	Any	No particular dressing	
C	Only de-accessed ports	Any	No	
D	Hickman catheter: cannot swim for the first 3 weeks or until tissue adherence to the cuff can be assured Ports: once pocket is healed and not accessed No PICC unless cuffed	Ocean Pool Private hot tubs	Catheter coiled up + Tegaderm® covering the entire dressing	After swimming, remove Tegaderm and perform site care w/Chloraprep, gauze, & tape Cuffed PICC use Aqua guard
E	Un-accessed ports Cuffed PICCs 6 mos. post placement	Ocean Pool	Water proof tape	Clean site after swimming
F	No information (situation has not come up)			
G	PICCs: no swimming Hickman: yes, once catheter in place > 1 mos. Port: un-accessed > 1 mos. post placement	Chlorinated pool ONLY	Hickman: standard dressing	Hickman: change dressing immediately after swimming
H	Yes: Broviac Hickman Medcomp Once exit site is healed	Pool		Change dressing immediately after ad clean the outside of the catheter with chlorhexidine
I	Babies: NO Some older patients do swim	Chlorinated pools	Cover and protect the whole Broviac with another dressing that would encompass the whole original dressing + catheter Have used AquaGuard® in the past	Change the central line dressing immediately after swimming
J	Minimum swimming (usually only special occasions)	Private backyard swimming pools They can splash around in other bodies of water	AquaGuard® or large Tegaderm®	Lines need to be in for at least 6 weeks prior to swimming Dressing is changed as soon as the child is done swimming If the patient begins to have site infections the privilege is lost
K	Only de-accessed ports			
L	Tunneled central venous access device (CVAD) De-accessed ports	Chlorinated pools only	A watertight dressing should be worn over the catheter exit site while swimming. If the dressing comes off or if there is moisture present beneath the dressing the patient should cleanse the site and apply a new dressing immediately after swimming. It is also important to cover the end connector and the connection between the catheter hub and the end connector. This is a potential	

HPN Program	Do you allow your patients to swim with a CVC?	Bodies of water allowed	Dressing/PICC line covers	Other rules
			point of entry into the catheter lumen itself and should also point of entry into the catheter lumen itself and should also	be secured with a watertight covering be secured with a watertight covering
M	No swimming			
N	No swimming			
O	Yes	Pools only	Catheter coiled up + large Tegaderm®	
P	No swimming			