Effect of Dolphin® Fluid Immersion Simulation® (FIS) on High-Acuity Cases Within a Long-Term Acute Care Hospital

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Abstract: This study follows cases placed on Dolphin FIS therapy within an LTACH environment. Specifically, cases tracked for prevention were placed on the system to prevent breakdown post code, and cases placed on the system for treatment admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury. 41 total cases were tracked within September 2017 through March 2018. The average time spent on the system was 4.44 weeks with a max of 8 weeks, an overall improvement of wound size by 47% with zero breakdown within prevention cases.

INTRODUCTION

The intention of this study is to track progress of patients admitted to a long-term acute care hospital (LTACH) who were placed on the Dolphin® Fluid Immersion Simulation® (FIS) mattress replacement system. The FIS System is an advanced therapy system designed to provide state-of-the-art pressure redistribution by simulating the effects of a body immersed in a fluid medium utilizing the specific characteristics of the individual patient as they engage the support surface, creating an individualized immersion profile that creates a near-neutral buoyant state (Joerns Healthcare, 2018).

Based on previous publications supporting the use of Dolphin FIS on high-acuity cases (Kohanzadeh, Breithaupt, Bondarchulk, & Bhavsar, 2009) and previous care protocol implemented by wound care team at facility2, this study will focus on two aspects of fluid immersion therapy: prevention and healing. Prevention will look at an initiative implemented at this LTACH, where all post code and high-risk patients will be placed on the Dolphin FIS System. This study will also focus on high-acuity patients admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury.

Facility protocol will be followed per case. The data that are tracked will solely look at duration on the Dolphin FIS System, change in wound size, breakdown in prevention cases, and resolution. Cases placed on Dolphin for prevention were assessed on whether there was breakdown or not, and for how long they were on the surface. Cases placed for healing were measured weekly and documented.

The goal of this study was to understand if placement of patients on the Dolphin FIS mattress replacement would impact wound healing times, as well as, prevent breakdown for those at high risk while supporting cost containment within facility.

Dolphin® FIS
Fluid Immersion Simulation®

POPULATION

The population strictly focuses on admission criteria for high-acuity patients. From the admission criteria, there were 41 total cases. Four cases fell under prevention, three per protocol, and one fell under the prevention of post-flap surgery. There were 38 total cases that fell under the healing label [Figure 1]. As demonstrated in Figure 2, of the 38 cases tracked 12 were Unstageable, six Stage 2, six Stage 3, two Stage 4, and four Deep Tissue Injury (DTI) cases were tracked. There were no cases of Stage 1 placed on Dolphin FIS for this study.

Figure 1: Dolphin placement for prevention of treatment

	FREQUENCY	PERCENT
Prevention	3	7.3
Treatment	38*	92.7
TOTAL	**41**	**100**

*One case was resolved via flap and continued on Dolphin for prevention.

Figure 2: Cases tracked for assessment at initial Dolphin placement

	FREQUENCY	PERCENT
Unstageable	12	31.6
Stage 2	6	15.8
Stage 3	6	15.8
Stage 4	2	26.3
DTI	4	10.5
TOTAL†	**30**	**100**

†There were 0 cases of Stage 1 PI placed on Dolphin FIS.

RESEARCH QUESTIONS

RESEARCH QUESTION 1:

What effect will Dolphin FIS have on outcomes within the LTACH environment?

H1a 0: There is no significant association between Dolphin FIS and outcomes within the LTACH environment.

H1a alt: There is a significant association between Dolphin FIS and outcomes within the LTACH environment.

RESEARCH QUESTION 2:

What effect will Dolphin FIS have on healing rates for cases admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury?

H2a 0: There is no significant association between Dolphin FIS and cases admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury.

H2a alt: There is a significant association between Dolphin FIS and cases admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury.

RESEARCH QUESTION 3:

What effect will Dolphin FIS have on prevention of breakdown for post code and high-risk cases?

H3a 0: There is no significant association between Dolphin FIS and prevention of breakdown for post code and high-risk cases.

H3a alt: There is a significant association between Dolphin FIS and prevention of breakdown for post code and high-risk cases.

STUDY DESIGN

Patients who were admitted to LTACH per admission criteria were tracked from **August 2017 through March 2018.** Cases that fell under treatment were documented weekly and grouped by total duration of stay on Dolphin.

Cases were documented for their initial assessment at time of Dolphin placement and their final measurement or at week 8, whichever came first. Cases that fell into prevention were measured on whether or not there was breakdown, and the duration of placement on the Dolphin FIS System.

For cases in the treatment group, wound size was tracked weekly for length, width, and depth (D. Langemo, 2008). If any measurement was unable to be determined, a numerical value was given for the first determination of that measurement. If the wound was resolved before a measurement could be determined, a measurement of 0.1 cm was given. Each wound was translated into wound size. Wound size was determined by adding each measurement [L+W+D] together. Measurement of volume via multiplication of measurements was determined not applicable, as allocation of undermined measurements could cause misleading results. Wound size was calculated at initial assessment and at final assessment. Cases were tracked for resolution during time period and documented accordingly. Cases were also tracked for dimensional changes from initial measurement to final measurement. If there was a decrease in either length, width, and/or depth this was documented as either no improvement, 1-dimensional, 2-dimensional, or all 3-dimensional improvements. Cases were also tracked for resolution of wounds. Additional wound assessment criteria were also tracked for duration, but found to have insignificant impact on overall wound size.

Descriptive analysis was run to look at summation of cases. Outcomes were tracked for breakdown dimensional change, and for wound size change both in total cm and in percentage. Correlation analysis was run to determine if there was an association between Dolphin FIS and positive outcomes. Additional correlation analysis was run to determine if there was a significant association between cases placed on Dolphin FIS for prevention and skin breakdown. Linear regression analysis was run to look for correlations within change in wound size and overall percentage of improvement. This regression used weeks on the Dolphin FIS System to identify whether a predictor variable was present. A significance level of ≥0.05 will be considered statistically significant.

RESULTS

Table 1: Average results for length of treatment and average improvement

	MEAN
Weeks on Dolphin FIS	4.44
Initial size (cm)	14.11
Final size (cm)	8.85
Change from initial measurement (cm)	5.13
Percentage of improvement	46.9

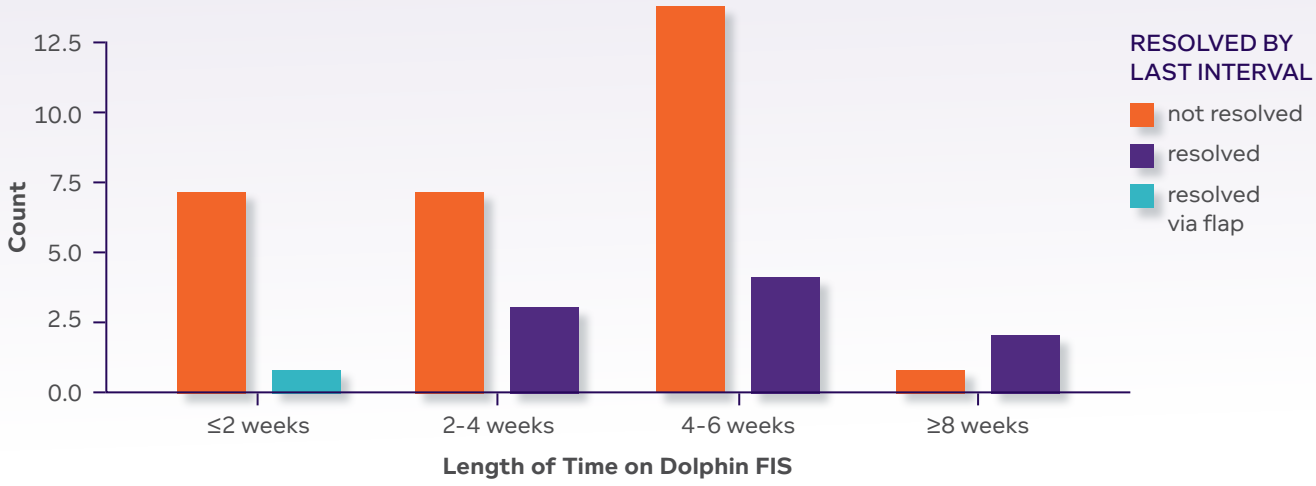
As demonstrated in Table 1, of cases that were placed on the Dolphin FIS System, there was an average of 47% improvement in overall wound size. 10 of the 38 cases were completely resolved, one of which was via flap and placed on the system for prevention. 89.5% of cases showed improvement from initial measurements.

RESULTS (continued)

Table 2: Duration of placement compared to resolution of case

	NOT RESOLVED	RESOLVED	RESOLVED VIA FLAP	TOTAL
≤2 weeks	7	0	1	8
2-4 weeks	7	3	0	10
4-6 weeks	14	4	0	18
≥8 weeks	1	2	0	3
TOTAL	29	9	1	39

Figure 3: Duration of placement compared to resolution of case



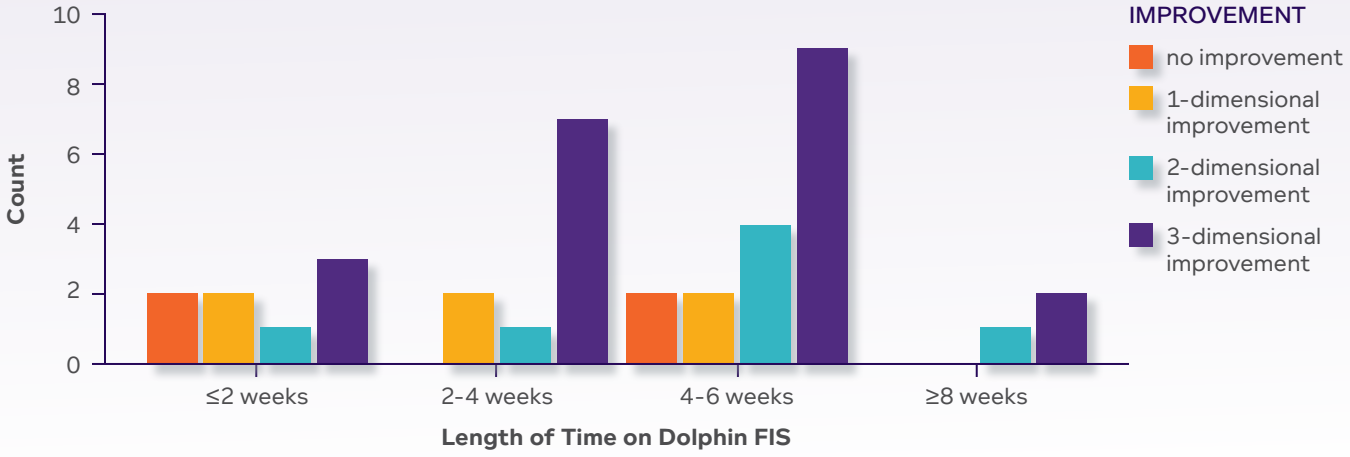
In Figure 3, more detail is provided for length of time on Dolphin FIS and whether the case was resolved. The average duration was roughly one month. There is an association seen here that length of stay does have an effect on resolution of the case.

RESULTS (continued)

Table 3: Short- and long-term duration outcomes

	NO IMPROVEMENT	1-DIMENSIONAL IMPROVEMENT	2-DIMENSIONAL IMPROVEMENT	3-DIMENSIONAL IMPROVEMENT	TOTAL
≤2 weeks	2	2	1	3	8
2-4 weeks	0	2	1	7	10
4-6 weeks	2	2	4	9	17
≥8 weeks	0	0	1	2	3
TOTAL	4	6	7	21	38

Figure 4: Duration of placement compared to dimensional improvement



Broken down further, Table 3 and Figure 4 demonstrate that though not all cases were resolved, there was an association: as the stay on the system increased, the outcomes improved. Here it is demonstrated that each dimension on its own was assessed for improvement. If there was improvement per measurement from initial measurement to final measurement, this was calculated as 1-dimensional improvement. If length, width, and depth improved, this was counted as 3-dimensional improvement. Any two improvements were documented as a 2-dimensional improvement.

RESULTS (continued)

Table 4: Duration of cases placed for prevention compared to skin breakdown

	NO BREAKDOWN	BREAKDOWN	TOTAL
≤2 weeks	1	0	1*
4-6 weeks	3	0	3
TOTAL	4	0	4

*One case was resolved via flap and continued on Dolphin for prevention.

In Table 4, it is demonstrated that of the cases that were placed on Dolphin FIS for prevention, no breakdown occurred. Though there was a small sample size, this is consistent with the rest of the findings that time spent on the Dolphin FIS System aids in the improvement of outcomes.

STATISTICAL ANALYSIS

RESEARCH QUESTION 1:

There was a positive correlation between length of time on Dolphin FIS and three predictor variables, two of which reached significance and the third neared significance. Associating both level of improvement, r=0.260, n=41, *P*=0.05, and percentage of improvement, r=0.389, n=37, *P*=0.009, demonstrated significant results. Looking at final measurement size, there was a positive correlation that neared significance r=-0.242, n=40, *P*=0.66 when compared to time spent on Dolphin. This indicates that the null hypothesis can be rejected with two significant associations, stating Dolphin FIS has a significant association with positive outcomes based on admission criteria.

Table 5: Correlation analysis of effect on outcomes in LTACH environment

		WEEKS ON FIS	IMPROVEMENT	L+W+D FINAL SIZE	PERCENTAGE OF IMPROVEMENT
Weeks on FIS	Pearson Correlation	1	0.260*	-0.242	0.389*
	Sig. (1-tailed)		0.050	0.066	0.009
	N	41	41	40	37
Improvement	Pearson Correlation	0.260*	1	-0.513*	0.613*
	Sig. (1-tailed)	0.050		0.000	0.000
	N	41	41	40	37
L+W+D Final size	Pearson Correlation	-0.242	-0.513*	1	-0.703*
	Sig. (1-tailed)	0.066	0.000		0.000
	N	40	40	40	37
Percentage of improvement	Pearson Correlation	0.389*	0.613*	-0.703*	1
	Sig. (1-tailed)	0.009	0.000	0.000	
	N	37	37	37	37

*Correlation is significant at the 0.05 level (1-tailed).

STATISTICAL ANALYSIS (continued)

RESEARCH QUESTION 2:

A linear regression was calculated to predict level of improvement based on the number of weeks a case was placed on Dolphin FIS. There was a significant effect of weeks of treatment on percentage of wound size improvement at the b=8.37, SD=3.35, *P*=0.017. A significant regression equation was found [F (1,35)=6.245, *P*=0.017 with a R^2 of 0.151].

This shows that there is a significant association that time spent on Dolphin FIS can predict level of improvement. As a result, we can reject the null hypothesis stating there is a significant association between Dolphin FIS and cases admitted with mechanical ventilation and/or Stage 3, 4, or Unstageable Pressure Injury. Further interpretation indicates a significant prediction that for every one week spent on Dolphin FIS, the wound size will improve by 8.37%. Figure 5 further demonstrates the linear equation representing that time spent on Dolphin FIS has a positive correlation with percentage of wound improvement.

Table 6: Model summary linear regression weeks on FIS/percentage of improvement

MODEL	R	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE
1	0.389[a]	0.151	0.127	34.63784

Table 7: ANOVA weeks on FIS/percentage of improvement

	MODEL	SUM OF SQUARES	dF	MEAN SQUARE	F	SIG.
1	Regression	7492.343	1	7492.343	6.245	0.017[b]
	Residual	41992.287	35	1199.780		
	TOTAL	**49484.630**	**36**			

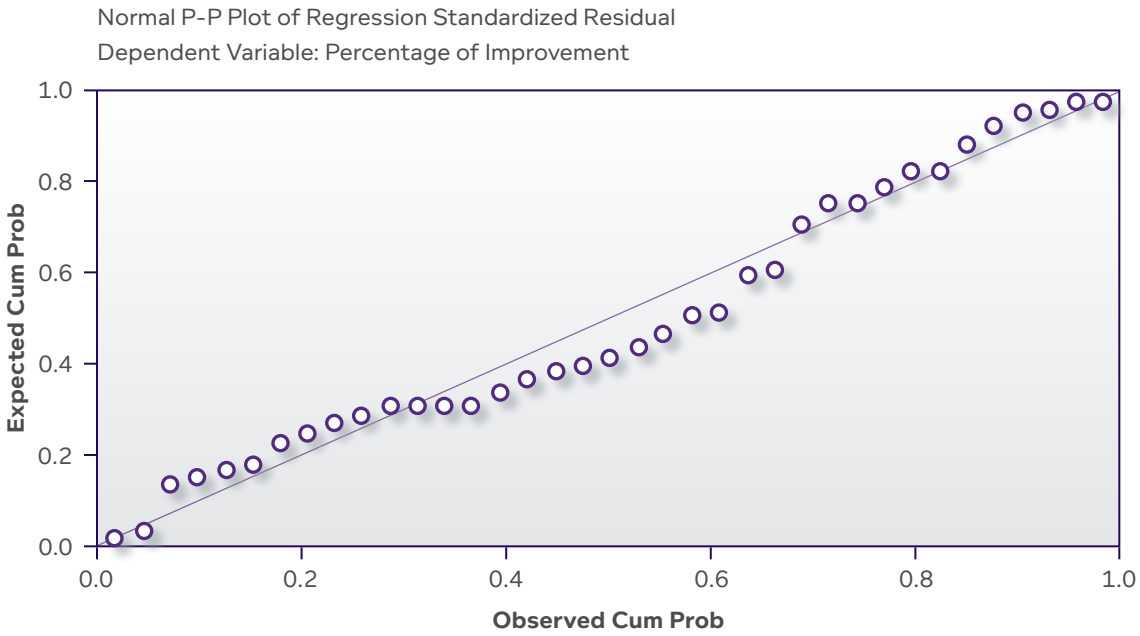
STATISTICAL ANALYSIS (continued)

RESEARCH QUESTION 2 (continued):

Table 8: Linear regression coefficients weeks on FIS/DV: Percentage of improvement

MODEL		UNSTANDARDIZED COEFFICIENTS		STANDARDIZED COEFFICIENTS	t	SIG.
		B	Std. Error	Beta		
1	(Constant)	9.816	15.892		0.618	0.541
	Weeks on FIS	8.365	3.347	0.389	2.499	0.017

Figure 5: Plot of linear regression weeks on FIS/DV: Percentage of improvement



STATISTICAL ANALYSIS (continued)

RESEARCH QUESTION 3:

Table 9: Correlation association Dolphin FIS as prevention and breakdown while on surface

CORRELATIONS				
		Is Dolphin for treatment or prevention?	**Prevention result**	**Resolved by last interval**
Is Dolphin for treatment or prevention?	Pearson Correlation	1	-0.092	-0.354*
	Sig. (1-tailed)		0.283	0.012
	N	41	41	41
Prevention result	Pearson Correlation	-0.092	1	0.215
	Sig. (1-tailed)	0.283		0.089
	N	41	41	41
Resolved by last interval	Pearson Correlation	-0.354*	0.215	1
	Sig. (1-tailed)	0.012	0.089	
	N	41	41	41

*Correlation is significant at the 0.05 level (1-tailed).

In Table 9, the results demonstrate a significant correlation between Dolphin being used for prevention, and resolution with positive outcome as evident by r=-0.354, n=1, *P*=0.012. Since limited cases were admitted for prevention, a statistically significant correlation could not be calculated with only the four cases. Looking for a correlation between breakdown and being placed on surface for prevention was able to demonstrate a significant result.

DISCUSSION

These data indicate that when used for complex admissions, Dolphin FIS meets the needs and is associated with both better outcomes, and a prevention of skin breakdown. The statistical analysis allows for the rejection of each null hypothesis, and helps validate previous publications stating the effectiveness of Dolphin FIS in pressure (injury) ulcer development (Kohanzadeh, Breithaupt, Bondarchulk, & Bhavsar, 2009). Medical complex cases have many variables that can be associated with wound healing. It was determined that in order to generate the strongest data, it was either all variable to be included or to simply look at cases on Dolphin FIS. Theoretically, if there was confounding data, this would be offset by the occlusion of variables. Over a 6-month period, 41 cases were placed on Dolphin FIS, including those that were placed for prevention. There was an overall 47% improvement in wound size. The cases placed for prevention did not show breakdown for duration of placement. This further strengthens the claims of Dolphin FIS technology use in high-acuity cases.

Based on previous clinical outcomes and validated within this study, along with the ease of clinician use as well as significant cost savings, the Dolphin FIS System has become the surface of choice in the facility's high-acuity prevention and treatment protocol (Ochs, 2005). Based on the wound care team's treatment and known local success, it was important to put significant values behind their work. The data generated within this study support what this wound care team already knew, that when used appropriately, **Dolphin FIS supports needed care levels and ease of use and allows for overall cost savings.**

Limitations

This study did not include additional variables; all patients followed protocol put in place within care environment. It was felt the occlusion of additional variable would have the same result as inclusion of all variables, thus allowing for time spent generating accurate measurements. There were two clinicians originally conducting measurements, but one recused herself for an additional employment opportunity. During time of data tracking there was a spike in admissions not fitting criteria of population for study, leading to a lull of available data. This facility has moved exclusively to Dolphin FIS for high-acuity admissions and high-acuity prevention. There was no option to compare to similar technologies. Tracking comfort level of cases would have been an additional complement to the data collected.

Significance

It has been stated that Dolphin Fluid Immersion simulates a 3-dimensional state that separates it from other mattress replacement systems. Taking on high-acuity cases within an LTACH setting and showing that for each week on the system an association of 8.37% improvement can be linked is a strong matter. There is yet to be a study showing that time spent on the Dolphin FIS System can be associated with prediction of positive outcomes within an LTACH environment. This study further supports the claim and should lead to additional research to track the effectiveness of the Dolphin FIS System within a high-acuity setting.

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