Development of an Air Support Surface Algorithm to Meet the Therapeutic Needs of Pediatric and Lower Weight Patients

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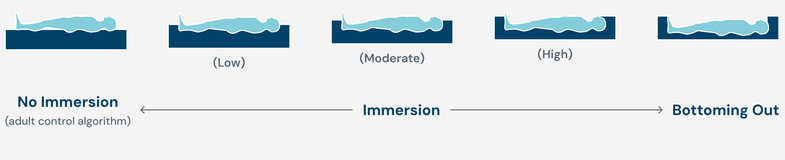
Background

- Most medical devices are not specifically designed for the pediatric population; the result is clinicians often must use or modify equipment intended for adults.
- In the utilization of support surface therapy for pressure injury prevention and treatment, therapeutic goals often center around providing pressure redistribution to the tissue, with one strategy being immersion and envelopment.
- Patients with acute pressure redistribution needs are typically placed on powered air support surfaces programmed with an algorithm that controls how the product behaves.
- When lower weight or pediatric patients are placed on an air support surface designed for adult patient weight loads, the Internal Support Surface Pressure (ISSP) regulated by the control algorithm is often too high. This results in an overly firm support surface that does not allow the patient to sink into the air cells, therefore providing little to no immersion and pressure redistribution therapy for the patient.

Purpose

For pressure redistribution to be achieved in pediatrics, the control algorithm for the air support surface must maintain a lower ISSP within the air cells. Lower internal pressures create an overall softer surface that can react to lower weight patients, allowing them to immerse into the mattress. The goal was to develop an air support surface algorithm capable of operating therapeutically at lower ISSPs. As pediatric patients receive care on both full- and crib-size bed frames, the algorithm also needed to control surfaces with widely different internal air volumes.



Resources

1. *Ann Marie Nie, Hawkins-Walsh E, Delmore B. Risk Factors Related to the Development of Full-thickness Pressure Injuries in Hospitalized Pediatric Patients. PubMed. 2024;37(9):480-488. doi:https://doi.org/10.1097/asw.0000000000000194*
2. *Nie AM, Delmore B. Hospitalized Pediatric Patients: Risk Factors Related to the Development of Immobility-Related and Medical Device-Related Pressure Injuries. Advances in Skin & Wound Care. 2025;38(2):76-85. doi:https://doi.org/10.1097/asw.0000000000000271*
3. *CDC. Growth Charts - CDC Extended BMI-for-Age Growth Charts. www.cdc.gov. Published October 12, 2023. https://www.cdc.gov/growthcharts/cdc-growth-charts.htm*

Special thanks to Chad Miller and Ricardo Rendon for their assistance with testing logistics.

Methodology

Pediatric care spans from infancy through adolescence. To capture a wide range of potential patients, twenty-four pediatric volunteers of varying ages and sizes were brought in for initial data collection. Participant's height, weight, and age were recorded. In addition to the usual variations in individual body habitus, the therapeutic needs of this population change based on the developmental status of the patient.[1, 2, 3]

Clinician feedback indicates that infant and toddler sized patients may receive care on a full-sized surface, rather than a crib-size surface, to allow adequate space for additional medical devices. With this knowledge, participants were asked to lay supine on either a full-size air support surface, a crib air support surface, or both if they were able. Surfaces were controlled by an adaptive, dynamic pressure immersion control algorithm programmed to provide lower ISSPs at eight predetermined settings. ISSP setting was recorded for each participant when therapeutic immersion was achieved.

Verification of therapeutic immersion and absence of bottoming out was achieved with clinical assessment provided by licensed and certified clinicians with subject matter expertise in support surface therapy. Clinical assessment included:

- Hand checks under areas of bony prominence including the occiput and sacrum
- Visual assessment of increased surface area contact between the participant and the support surface
- Asking participants for verbal feedback on comfort utilizing developmentally appropriate questions

Assessment was also completed at one setting above and one setting below the recorded ISSP setting to demonstrate the algorithm's ability to provide a continuum of immersion therapy to meet individual patient care goals. Both height and weight were correlated against the recorded therapeutic ISSP setting for data analysis.

With preliminary analysis of the data and algorithm performance, the team moved to develop two separate control algorithms for the full and crib size surface, both utilizing similar adaptive strategies. To validate the refined version of the control algorithms, a second focus session utilizing nine participants of interest from the first study was completed with the above methodology.

Results

Data analysis for the study indicated a closer correlation between participant weight and therapeutic ISSP compared to participant height vs therapeutic ISSP.

Low ISSPs can be challenging to achieve through typical control algorithms used in adult support surfaces. Using a dynamic airflow immersion algorithm with an adaptive timed-exhaust feature to achieve low ISSPs resulted in a continuum of therapeutic immersion for the pediatric participants.

AGE	SUBJECT HEIGHT (in)	SUBJECT WEIGHT (lb)	CRIB ISSP SETTING (1-8)	FULL-SIZE ISSP SETTING (1-8)
1 month (mannequin)	20	7	1	1
2 months (mannequin)	20	11	1	1
5 months (mannequin)	20	15	1	1
2 years	33	22.3	2	2
1 year	29.5	23.6	2	2
4 years	38.5	33	3	2
6 years	40	34.6	3	2
5 years	40.5	40.2	3	2
4 years	44	50	3	2
10 years	56	91		4
12 years	59.5	96.4		4
11 years	62.5	99.8		4
7 years	53	102.8		6
11 years	61.5	108		4
14 years	63.5	127		4
12 years	60	140		6
13 years	63	192		6

Conclusion

Therapeutic pressure redistribution for pediatric and underweight patients can be achieved on full**- and crib***-sized support surfaces by utilizing a dynamic airflow control algorithm with learned timed exhaust to lower internal support surface pressures.

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