SickKids
THE HOSPITAL FOR
SICK CHILDREN

Development and Evaluation of Novel Dynamic Bar for Foot Abduction Brace for Clubfoot Treatment

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Sponsor: The Hospital for Sick Children

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STATEMENT OF COMPLIANCE

The trial will be conducted in accordance with this protocol, International Council on Harmonization Good Clinical Practice (ICH GCP) and applicable regulatory requirements. The Principal Investigator (PI) will assure that no deviation from, or changes to the protocol will take place without prior agreement from the Sponsor and documented approval from the Research Ethics Board (REB), except where necessary to eliminate (an) immediate hazard(s) to the trial participants.

The protocol, informed consent form, recruitment materials, and all participant materials will be submitted to the REB for review and approval. Approval of both the protocol and the consent form must be obtained before any participant is enrolled. Any amendment to the protocol will require review and approval by the REB before the changes are implemented to the study. All changes to the consent form will be REB approved; a determination will be made regarding whether a new consent needs to be obtained from participants who provided consent, using a previously approved consent form.

Name of Principal Investigator (Print): Maryse Bouchard

Signature of Principal Investigator:  Date: 26 November 2021

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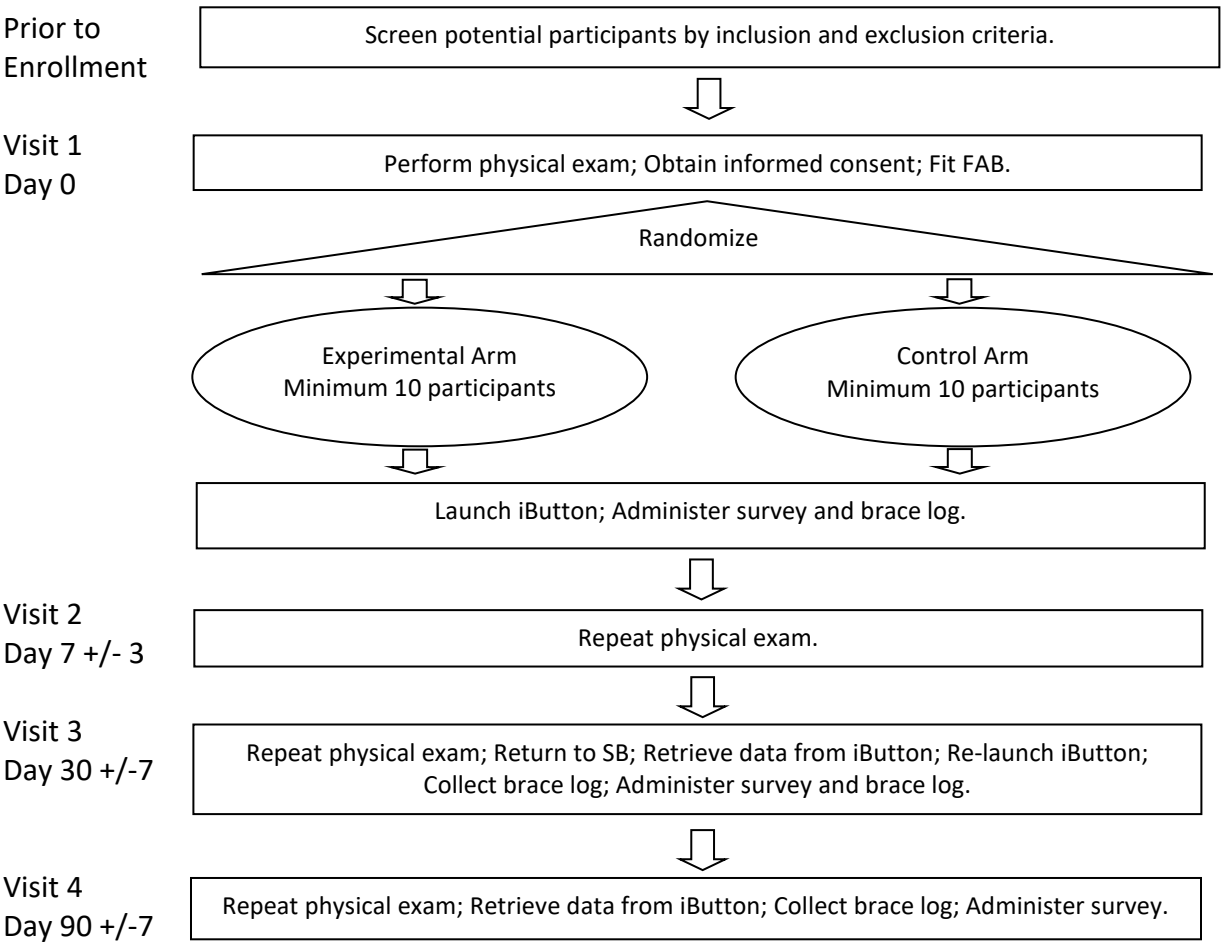
1 PROTOCOL SUMMARY

1.1 SYNOPSIS

Title:	Development and Evaluation of Novel Dynamic Bar for Foot Abduction Brace for Clubfoot Treatment
Study Description:	This is an assessor-blinded randomized feasibility trial assessing the feasibility of conducting a large-scale clinical trial to evaluate the effectiveness of a new dynamic bar for foot abduction bracing for clubfoot treatment. Feasibility will be determined by the ability to recruit patients within the goal study period and to retain participants. Eligible patients must have a well-corrected idiopathic clubfoot (Pirani Score ≤ 0.5) and be in the minimum 12 hours per day bracing stage of the Ponseti clubfoot treatment protocol. The overall study period will be 90 days in length. For the first 30 days, the experimental cohort will wear the new Dynamic Bar (DB) with standard ankle-foot orthoses (boots) and the control cohort will continue wearing their Standard Bar (SB). After this 30-day period, the experimental cohort will return to wearing their SB. All patients will be evaluated on Day 0, Day 7, Day 30, and Day 90 of the study period to monitor for recurrence of the clubfoot deformity, complications of brace wearing, to submit brace wear logs, and to complete parent-reported questionnaires regarding their perceptions of the Foot Abduction Brace (FAB) and their child's comfort. A minimum of 10 patients per arm will be recruited. A temperature sensor will be added in each participant's boots during the 90-day study period to objectively measure time of brace wear. It is hypothesized that when patients are wearing the DB, they will experience higher brace tolerance defined as increased wear time of the brace as measured by the temperature sensors, and higher comfort levels as reported by parents, without an increase in clubfoot deformity recurrence compared to the SB. Most patient health information will be collected and stored in the SickKids Clubfoot Research Registry (REB #1000053919).
Objectives:	Primary Objective: To evaluate the ease of recruiting and retaining participants for a randomized-controlled effectiveness trial of a novel FAB bar. Secondary Objectives: 1) To compare parental perception of the child's comfort in the SB versus the DB for foot abduction bracing in Ponseti clubfoot treatment. 2) To compare patient tolerance of the SB to the DB by how many hours the brace is worn per day as recorded by temperature sensors placed in the boots and by parent self-reported log of brace wear. 3) To perform a preliminary assessment of the effectiveness of the DB at preventing clubfoot recurrence during the bracing phase when the brace is worn as prescribed for a 30-day trial period.

Endpoints:	Primary Endpoint: Recruitment rate, dropout rate, and related responses on the parent-reported survey. Secondary Endpoints: 1) Patient comfort levels determined by parent-reported surveys with 5-point Likert scale responses completed at Day 0, Day 30, and Day 90 of the study period. 2) Daily brace wear hours as measured by a parent self-reported log and by temperature sensors implanted inside the boots. 3) Presence of clubfoot recurrence defined as a Pirani score > 0.5 representing any new development of cavus, adduction and/or hindfoot varus, or a loss of passive ankle dorsiflexion (equinus) of < 10 degrees above neutral or a reduction of 5 or more degrees from the previous visit.
Study Population:	20 patients with well-corrected unilateral or bilateral idiopathic clubfoot deformity, aged 1 to 3 years, who are using a SB with their FAB for the minimum 12-hour per day bracing stage of their Ponseti treatment at the Hospital for Sick Children.
Phase:	N/A
Description of Study Intervention:	There are multiple intervention devices (bars) that will be compared during foot abduction bracing for clubfoot treatment. The control cohort will wear their standard bar with the standard boot for 90 days. The experimental cohort will wear a new dynamic bar with the standard boot for 30 days, then return to their SB for 60 days. The novel bar is designed by the research team and allows independent movement of the knees and hips while maintaining a corrective position of the foot.
Study Duration:	5 months
Participant Duration:	3 months

1.2 SCHEMA



1.3 SCHEDULE OF ACTIVITIES (SOA)

Procedures	Screening Day -30 to -1	Baseline, Visit 1 Day 0	Study Visit 2 Day 7 +/- 3 days	Study Visit 3 Day 30 +/-7 days	Study Visit 4 Day 90 +/- 7 days
Chart Review for screening	X				
Measure patients for appropriate size of SB and DB		X			
Informed consent		X			
Complete Consent Discussion Form		X			
Randomization		X			
Prescribe study intervention (new DB or original SB)		X			
Launch/retrieve data from temperature sensor in boot		X		X	X
Physical exam		X	X	X	X
Adverse event review			X	X	X
Administer surveys		X		X	X
Video record patients in their prescribed bar				X	

Procedures	Screening Day -30 to -1	Baseline, Visit 1 Day 0	Study Visit 2 Day 7 +/- 3 days	Study Visit 3 Day 30 +/-7 days	Study Visit 4 Day 90 +/- 7 days
Distribute/collect brace wear log		X		X	X
Document on study enrollment log	X	X	X	X	X

2 INTRODUCTION

2.1 BACKGROUND

Clubfoot, also known as congenital talipes equinovarus (CTEV), is the most common congenital orthopaedic deformity, occurring in approximately 1 in 1,000 live births (1). The affected foot is characterized by an excessive down-and-in position (equinovarus) with a high medial longitudinal arch (cavus). Without treatment, clubfoot can result in long-term disability and pain. Standard of care for treatment of clubfoot is the Ponseti method. It consists of gentle manipulation and serial casting of the foot, followed by a percutaneous Achilles tenotomy. The correction is then maintained using a foot abduction brace (FAB). Typical wear schedule for the FAB is 23 hours per day for the first three months, then at night only (aiming for 12 hours per day) until 5 years of age (2). Ideal position for the clubfoot in the FAB is 10 degrees of ankle dorsiflexion and 60 degrees of external rotation with the feet held shoulder-width apart (3).

Foot abduction braces consist of two ankle-foot orthosis (boots) connected by a shoulder-width bar. Most standard bars are straight and significantly limit independent knee and hip movement. Studies have reported that some parents perceived their child is uncomfortable wearing the FABs with a straight bar with up to 61% of idiopathic clubfoot patients not complying to the prescribed bracing schedule (3). Lack of brace tolerance and inadequate time in brace are shown to increase risk of recurrence (3).

Alternative bars for FABs that include hinges for added motion are few. One current and popular design, the Dobbs Bar, has hinges in the coronal plane to provide the patient with some independent mobility of the legs. See Appendix A for images of the Dobbs bar. Studies suggest that this independent mobility is directly correlated to greater comfort, as patients using the Dobbs Bar have greater rates of compliance and lower rates of recurrence (4). However, the Dobbs Bar features a spring-loaded mechanism in the hinge to return the patient's feet to the best-corrected position. Many patients can over-power the springs enabling intermittent loss of the corrective foot position by allowing plantarflexion and inversion of the feet. This might also allow the deforming muscles, the tibialis posterior and the plantarflexors of the feet, to strengthen as they contract against the spring, possibly contributing to further muscle imbalance and increasing the risk of clubfoot recurrence. This bar is also more expensive than the SB and is not covered by the Ontario Assistive Devices Program (5).

2.2 STUDY RATIONALE

This study seeks to evaluate the feasibility of conducting a large-scale clinical trial to evaluate the effectiveness of a newly designed dynamic bar (DB) for foot abduction bracing in clubfoot treatment (see photos in Appendix A). This DB fixes the foot and ankle position relative to two L-shaped brackets at the end of each bar, in order to maintain a corrective foot position at all times during use and prevent over-activation of deforming muscles. It allows independent extension and flexion the knees and hips while restricting motion of the ankle into plantarflexion or inversion as the latter movements may

contribute to muscle imbalance or recurrence of the clubfoot deformity. It is hypothesized that this added leg mobility would reduce brace intolerance and improve child comfort without increased risk of recurrence.

Brace non-compliance is the leading cause of clubfoot recurrence (6,7). Reported recurrence rates after correction range from 20-41% and are higher the earlier the brace is discontinued (6). According to the Ponseti International website, the rate of recurrence when brace wear stops in the first year is 90%, 70–80% in the second year, 30–40% in the third, 10–15% in the fourth, and approximately 6% in subsequent years. (3) Intolerance and non-adherence to bracing affects an average of 35% of patients and can increase recurrence rates by anywhere 5- to 17-fold (3,6,7,8). The large variation in reported brace intolerance and clubfoot recurrence can be attributed to the lack of consensus regarding the definitions of ‘clubfoot recurrence’ and 'non-compliance' to bracing, as well as variation in the prescribed bracing schedules (7,9).

Brace compliance and actual brace-wear hours are very challenging to assess, and most studies only include parent-reported wear schedules (7). Studies have shown that parents tend to over-report daily brace wear times. To address this, we will use a small temperature sensor placed in each patient’s boots. These sensors have been used in past studies to provide objective measurements of daily bracing wearing times by measuring the temperature increase when the child is in the brace (10, 11,12). Automating the recording of daily brace wear will reduce human error and enable the study’s endpoints to be assessed more accurately.

Our new DB prototype has been trialed for a 10-minute period on 7 patients in the clubfoot clinic at the Hospital for Sick Children (SickKids) during their already scheduled follow up visit. This informal evaluation was conducted to get a sense of fit and motion and identify any critical aspects that might inform adjustments to the prototype design. Short surveys were administered to the physiotherapist applying the FAB and the parent to learn of their initial impressions of the DB (see Appendix B). Parent feedback was largely positive, and 6 out of 7 parents indicated that they would prefer their child to use a brace that gives them more freedom to move their feet. Physiotherapist assessment also confirmed that the bar maintains proper foot position and leg alignment during use.

2.3 RISK/BENEFIT ASSESSMENT

This DB has the potential to greatly improve patient and parent experience with clubfoot bracing during the night-time phase of treatment. By increasing the patient’s independent leg motion and comfort, brace tolerance should improve, and in turn, reduce the risk of relapse. By increasing brace wear, brace comfort and minimizing recurrence, this new bar design should lead to improved clinical outcomes, as well as patient and parent-reported outcomes.

The risks associated with the use of the DB prototypes includes all the risks associated with SBs, such as pressure sores and skin rashes. Additional risks associated with the DB might include bar malfunction or breakage, due to lack of extensive material evaluations. Clubfoot recurrence still occurs with the SB, but the risk may be increased with the DB as it will give patients unprecedented mobility. Walking in any foot abduction brace is not recommended, however the added mobility provided by the DB might enable safer mobility for the child possibly preventing injury and falls. To mitigate risks and complications, a blinded outcomes assessor will regularly evaluate the patients, and if any sign of clubfoot recurrence is observed, the child will immediately return to their original FAB with serial casting

as needed. The intervention period in this feasibility study is purposely short to avoid placing a child in a potentially ineffective brace for a prolonged period of time.

3 OBJECTIVES AND ENDPOINTS

OBJECTIVES	ENDPOINTS	JUSTIFICATION FOR ENDPOINTS
Primary		
To evaluate the ease of recruiting and retaining participants for a randomized-controlled effectiveness trial of a novel FAB bar.	Recruitment rate, dropout rate, and related responses on the parent-reported survey.	This informs on the potential barriers to recruitment and participation in a future larger-scale clinical trial to evaluate the effectiveness of the DB.
Secondary		
1) To compare parental perception of the child's comfort in the SB versus the DB for foot abduction bracing in Ponseti clubfoot treatment.	1) Patient comfort levels determined by parent-reported surveys with 5-point Likert scale responses completed at Day 0, Day 30, and Day 90 of the study period.	1) Child comfort in brace is critical to achieving full brace compliance. As our study subjects are aged 1-3 years and unable to complete surveys or communicate their experience, parent-proxy reported outcome measures are a validated method to use as an endpoint (13, 14).
2) To compare patient tolerance of the SB to the DB as measured by parent self-reporting and by how many hours the brace is worn per day as recorded by temperature sensors placed in the boots.	2) Daily brace wear hours as measured by a parent self-reported log and by temperature sensors implanted inside the boots.	2) Brace non-compliance is the leading cause of clubfoot recurrence. Therefore, increasing brace tolerance decreases clubfoot recurrence and leads to improved clinical outcomes.
3) To perform a preliminary assessment of the effectiveness of the DB at preventing clubfoot recurrence during the bracing phase when the brace is worn as prescribed for a 30-day trial period.	3) Presence of clubfoot recurrence defined as a Pirani score > 0.5 representing any new development of cavus, adduction and/or hindfoot varus, or a loss of passive ankle dorsiflexion (equinus) of < 10 degrees above neutral or a reduction of 5 or more degrees from the previous visit.	3) While there is no validated definition for clubfoot recurrence, our clinical endpoints are commonly used criteria in other clubfoot studies. Since this is a feasibility study with only 20 participants, safety and efficacy cannot be clinically proven but we want to ensure the design at least prevents early relapse during the night-time bracing phase before the DB is produced at-large.

4 STUDY DESIGN

4.1 OVERALL DESIGN

This is an assessor-blinded randomized controlled trial in which patients with well-corrected idiopathic clubfoot will be randomized to wear either their original SB (which is standard care for clubfoot treatment) or the new DB for 30 days. After 30 days, all participants will resume use of the SB and be monitored for an additional 60 days.

This study is a “feasibility trial” as it is assessing the feasibility of conducting a large-scale randomized controlled trial to evaluate the effectiveness of the DB. As such, feasibility will be determined by the ability to recruit patients within the goal study period and to retain participants.

On Day 0 of the study period, patients will be randomized and receive baseline clinical and questionnaire evaluations. A temperature sensor will be added in each participant’s boots during the 90-day study period to objectively measure time of brace wear.

All patients will be evaluated after 7 days in their assigned bar to check for brace fit, any complications, and to perform required adjustments. This 7-day checkup is standard care for clubfoot treatment when patients receive the SB and FAB for the first time.

After 30 days, the patients wearing the DB will resume use of the SB. All patients will be seen at the end of the first 30 days and after 90 days to monitor for recurrence of the clubfoot deformity, complications of brace wearing, and parent-reported perception of their child’s comfort with the FAB. Parents will also be asked to complete a self-reported brace wear log that will be collected on Day 30 and 90.

A minimum of 10 patients per arm will be recruited. Once there are 10 in each arm, recruitment will halt. It is hypothesized that patients using the DB will experience higher brace tolerance as measured by the temperature sensors, and higher comfort levels as reported by parents, without an increase in clubfoot deformity recurrence compared to the SB.

To compare the range of motion provided by the SB to the DB, and to verify that the DB consistently maintains proper foot position and leg alignment during use, parents will be given the option of consenting to video recordings being taken during the hospital visit of the patient’s feet and legs while wearing their prescribed bar. This recording will occur on Day 30 of the study period by a member of the study team. These videos will be closely studied to compare the range of motion provided by the SB to the DB, and to verify that the DB consistently maintains proper foot position and leg alignment during use. Note that audio will be removed from the videos.

Patient recruitment will be documented in an electronic enrollment log. To evaluate ease of recruitment, this enrollment log will also include patients who do not wish to participate in the study and their reason(s) for refusal. The enrollment log will also record information on patients that do not adequately fit the available prototype but are otherwise eligible, including patient age and fit issues. This will serve to inform future adaptations of the new DB.

During the intervention period, all patients will be monitored for brace fit by the PI and/or physiotherapist Barbara Harvey. A blinded outcomes assessor will clinically evaluate all patients to assess foot shape for possible recurrence or complications. The outcomes assessor will be a skilled clubfoot provider and will not be made aware of which bar was provided to the patient and is

independent of the design team. Once the trial is complete, the patient's care will resume with their primary clubfoot provider.

Clubfoot patients are normally reviewed in clinic every 3-6 months. If scheduling permits, Day 0 of the study period will align with patient's already scheduled follow up visit. All patients will therefore require either 3 or 4 extra visits (possibly on Day 0, and surely on Day 7, Day 30, and Day 90). These extra visits will consist of the same evaluations done in the routine clubfoot monitoring protocol, in addition to the study-related questionnaire, brace wear log, video recording (on Day 30 only), and temperature sensor data collection.

Three surveys will be administered to parents on Day 0, Day 30, and Day 90 of the study period. These surveys will be collected and managed using REDCap (Research Electronic Data Capture) hosted at SickKids. Parents will also be asked to complete a brace wear log to be submitted at Day 30 and Day 90 of the study period.

Most patient information that will be reviewed in this study is data being collected and stored per the REB-approved Clubfoot Research Registry protocol (REB #1000053919). All patients enrolled in study this will also be enrolled in Clubfoot Research Registry, if not already enrolled.

4.2 SCIENTIFIC RATIONALE FOR STUDY DESIGN

This trial design allows for direct comparison between SBs and the new DB, without affecting the patient's long-term treatment plan or outcomes. The assessments will be between patients (control vs. experimental cohorts) and within the same patient (experimental cohort wearing both bar designs).

Since participants in this feasibility trial will only use the DB for a maximum of 1 month, the likelihood of finding a difference in bar effectiveness is quite low. Therefore, following this feasibility trial, the study team plans to conduct a prospective randomized controlled trial of the novel DB versus standard bars, comparing the DB's effectiveness at maintaining ideal foot position and preventing recurrence over a minimum two-year period. A separate REB application will be filed for this trial.

Bias in brace wear reporting will also be mitigated in this feasibility study by using temperature sensors to objectively measure the time of brace wear, and by using quantitative evaluations done by blinded outcomes assessors to evaluate study endpoints.

To mitigate the risk of bias in the completion of the parent-reported surveys, the surveys were written using neutral language as much as possible. For example, instead of using the terms "standard" and "dynamic," the bar types were described using the terms "current," "original," and "alternative."

4.3 END OF STUDY DEFINITION

A participant is considered to have completed the study if he or she has completed all phases of the study including the last visit or the last scheduled procedure shown in Section 1.3, Schedule of Activities (SoA). The duration of participation for each individual participant who completes all study visits will be 3 months.

The end of the study is defined as completion of the last visit or procedure shown in the SoA in the trial globally. It is estimated that it will take 5 months from when the study opens to enrollment until the end of the study, as patient recruitment is expected to take approximately 2 months.

5 STUDY POPULATION

5.1 INCLUSION CRITERIA

In order to be eligible to participate in this study, an individual must meet all of the following criteria:

1. Ability of parent/care giver to complete brace wear log/surveys in English
2. Diagnosis of idiopathic clubfoot (unilateral or bilateral).
3. Current use of a SB with their Foot Abduction Brace.
4. In the minimum 12-hour per day bracing stage of the Ponseti treatment
5. Aged 1 to 3 years (as the DB prototype was designed based on the average size and strength of a child within that age group).
6. Well-corrected clubfoot/clubfeet (Pirani score ≤ 0.5)
7. Enrollment in the SickKids Clubfoot Research Registry.

5.2 EXCLUSION CRITERIA

An individual who meets any of the following criteria will be excluded from participation in this study:

1. Recurrent clubfoot deformity at time of recruitment and/or Day 0 in study period:
    - Pirani score above 0.5
    - Presence of cavus, adduction, or hindfoot varus
    - Less than 10 degrees of passive ankle dorsiflexion
2. Current complaint of significant brace intolerance.
3. Any condition or diagnosis, that could in the opinion of the Principal Investigator or delegate interfere with the participant's ability to comply with study instructions, might confound the interpretation of the study results, or put the participant at risk, i.e., skin conditions such as eczema, neurologic conditions or any non-idiopathic clubfoot, any acute or chronic illness perceived to be causing the child discomfort such as a cold or flu or other concurrent painful procedure.
4. The patient does not adequately fit the available prototype, e.g., shoulder width distance is too narrow or wide for prototype bar width. However, these patients will be recorded in the study enrollment log to identify the size of this subset. The age and fit issues of these patients will also be recorded to allow future adaptations of the new DB to accommodate this subset.
5. The patient is using an older boot model, in which a temperature sensor cannot be inserted, and the patient does not adequately fit the available boots, in which the temperature sensors have already been installed.

5.3 SCREEN FAILURES

Individuals who consent to participate in the clinical trial, but do not meet the criteria for participation in this trial, may be rescreened after 1 week to a maximum of 3 times. Rescreened participants should be assigned the same participant number as for the initial screening.

5.4 STRATEGIES FOR RECRUITMENT AND RETENTION

During the patient's regularly scheduled visit to the Hospital for Sick Children, parents will be asked by their clubfoot provider if they are interested in potentially participating in the trial. Should they be interested, further explanation will be provided by a member of the research team.

Since all participants will be 3 years or younger, patients will not have capacity to consent or assent for themselves. Therefore, parent consent will be sufficient for this study. Consent will be obtained by the research assistant and/or research coordinator and captured via an online REDCap form. For each new consent, a paper 'Consent Discussion Form' will be completed.

Patient recruitment will also be documented in an electronic enrollment log. This enrollment log will also include patients who do not wish to participate in the study and their reason(s) for refusal. The enrollment log will also record the age and fit issues of patients that do not adequately fit the available prototype but are otherwise eligible. This will serve to inform future adaptations of the new DB.

Participation in this trial is completely voluntary and parents may choose not to participate and may withdraw at any time. If parents choose to withdraw, this will be noted in the study enrollment log. Their collected data will continue to be used in the analysis unless the parent requests otherwise.

As an incentive for visit attendance, all participants will receive $20 CAD for each extra clinical visit (possibly on Day 0, and surely on Day 7, Day 30, and Day 90 of the study period) as compensation for travel expenses, given on the day of the final study visit.

6 STUDY INTERVENTIONS

6.1 STUDY INTERVENTION DESCRIPTION

An example of a straight SB is the Ponseti bar, which is a rigid, metal bar that clips on and off of the patient's boots by means of a patented "Quick Clip" mechanism (15). This bar is available in 3 sizes, depending on the patient's shoulder width. Designated as a class 1 medical device, this bar is used as standard care for clubfoot treatment (16).

The DB prototype is a 3-part bar, consisting of a crossbar with two L-shaped components on each end, which connect to the boots by the same "Quick Clip" mechanism. Each L-component is connected to the crossbar via a low friction slider, which allows for independent axial translation perpendicular to the crossbar, and a modified ball joint linkage, which allows for independent sagittal rotation.

The ball joint linkages also provide a small amount of independent axial and coronal rotation. This provides the patient with extra ankle dorsiflexion and abduction up to a maximum of 30 degrees in each direction. This allows for added movement through the knee and hips, reduces strain at the patient's joints, and reduces stress concentration at the hinges of the bar.

The L-components are machined using 5052-H32 aluminum and have a soft protective end cap to reduce the risk of any unintentional self-injuries. The crossbar and sliders are 3D printed using medical grade ABS plastic. They are attached using adhesive, two steel ball joint linkages, and various fasteners made out of steel and brass.

Ideal foot position for clubfoot is approximately 10 degrees of ankle dorsiflexion, and 60 degrees of external rotation with the feet held shoulder-width apart. This position is maintained as the DB is pre-bent to provide 10 degrees of ankle dorsiflexion, the external rotation can be adjusted with bolts, and the length of the bar can be adjusted with set screws. While the DB provides extra mobility, the ball joint linkages prevent patients' ankle dorsiflexion of less than 10 degrees and abduction of less than 60 degrees at all times during use. We anticipate that providing patients with more ankle dorsiflexion and external rotation than required will have no negative effects on patient outcomes.

The DB is compatible with the same boots as other SBs. Images of the Ponseti SB and the new DB can be found in Appendix A.

Since each DB prototype will be used on 2 patients during the trial, it will undergo cleaning and disinfection between patients. The Infection Prevention and Control department at SickKids confirmed that the use of CaviWipes, which is a hospital approved low level cleaner/disinfectant, will suffice for this device.

6.2 MANUFACTURING AND ADJUSTABILITY

The “Quick Clip” mechanisms from the Ponseti SBs are manufactured by MD Orthopaedics in Wayland, Massachusetts (17). The DB prototypes are mainly manufactured in-house by SickKids using 3D printing, however the machining of the L-components is outsourced to Sunnybrook Hospital. The DB will be preassembled and given to the participants ready-to-use.

The new DB can be adjusted via bolts and set screws, so that the feet are kept at specified abduction angles and shoulder-width distance apart. At the time of intervention, the DB will be sized to each patient by a clubfoot provider. The parent will also be educated on how to adjust the sizing of the bar should they need to.

6.3 MEASURES TO MINIMIZE BIAS: RANDOMIZATION AND BLINDING

Each patient will be assigned a unique study ID. Patients will be assigned to an arm by drawing lots. This will be done by preparing 20 opaque, sealed envelopes. 10 of these envelopes will contain the word "Experimental," and the remaining 10 will contain the word "Control." On Day 0 of the study period, each participant will choose an envelope at random, and be assigned to that arm. This technique will ensure that the ratio between patients in each arm is 1:1.

To minimize bias, the outcomes assessor, who is an advanced practice physiotherapist clubfoot provider, will be independent of the study and design teams and blinded, so they will not know which bar has been assigned to which patient.

To ensure that the outcomes assessor remains blinded, a member of the study team will check in the patient at the beginning of each visit, remind the patient and parent about the blinding, and ensure that the bar is removed and hidden from view before the outcome assessor enters the evaluation room.

Unblinding may occur for any participant who has experienced an adverse event, such as clubfoot recurrence, and must return to their original SB, if not already using it. Unblinding will occur for all participants if any severe adverse event occurs that is related to the use of the DB. For unblinding to occur, the outcomes assessor must notify a member of the study team, and any member of the study team may unblind the outcomes assessor.

All intentional and unintentional breaking of the blind will be documented in the study’s enrollment log, along with the reason(s) for unblinding. Per protocol, the Data Safety Monitoring Board and Research Ethics Board will also be notified of any adverse events or unblinding.

6.4 STUDY INTERVENTION COMPLIANCE

Standard care for clubfoot treatment is to assess bracing compliance by asking the parent about the patient's daily wear time at each scheduled appointment. Studies have shown that parents over-report brace wear by approximately 30% (12). To objectively measure brace compliance, a temperature sensor will be added in each patient's boots during the 90-day study period. Measurements obtained from these sensors will be used in the analysis of the 2nd secondary endpoint to compare brace wear time in the SB versus the DB. We will compare these results with parent self-reported logs of brace wear.

The temperature sensors that will be used are the DS1921G-F5 Thermochron iButtons, designed and manufactured by iButtonLink Technology in Wisconsin, USA. Each device is a battery powered data logger equipped with a temperature sensor. The devices will be set to record the temperature of the boots' insoles every 45 minutes and launched on Day 0 and Day 30 on the study period. The device complies with medical standards and is calibrated against a National Institute of Standards and Technology (NIST) traceable source (18). Thermochron iButtons have previously been used in a similar clubfoot bracing adherence study (19). The data obtained from these temperature sensors will be used to calculate the daily brace wear time of each patient during the interventions, by measuring the temperature increase when the child is in the brace.

For unilateral clubfoot cases, the temperature sensor will be placed in the boot that holds the clubfoot. For bilateral cases, the sensor will be placed on the right boot. To implant each sensor, technicians at SickKids will drill a hole through the sole of the boot and insert the iButton with an interference fit. This hole will be located directly over top of the slider in the "Quick Clip" mechanism, so that the slider secures the sensor and prevents it from falling out. The insole of the boot will be then covered with a layer of ShearBan® in order to ensure patient comfort and to ensure that the temperature sensor never comes into contact with skin. ShearBan is a self-adhesive film often used in insoles and orthopaedic braces (20). This procedure mimics that of another clubfoot brace compliance study, for which an installation video has been created (21).

The orthotics department will ensure that implantation of the iButton does not compromise the fit or function of the boots. Depending on the size and model of the participant's current boots, each participant will either receive a new boot that is pre-fitted with an iButton sensor, or the iButton sensor will be inserted into their current boot on Day 0 of the study period. If a new boot was given, the study team will collect this boot on Day 90 of the study period, and the participant will return to their original boot. If the iButton sensors are reused for different participants in the study, each sensor will be cleaned with alcohol wipes in between patients as advised by the Infection Prevention and Control department at SickKids.

To launch and retrieve data from the temperature sensors, a member of the study team will have to briefly remove the sensor from the boot on Day 0, Day 30, and Day 90 of the study period. When reinserting the sensor, the research team will ensure that the hole is re-covered with a layer of ShearBan.

If the participant is using their original boots and the parent wishes to remove the sensor after the study is complete, the research team will remove the sensor and cover the hole with a layer of ShearBan.

7 DISCONTINUATION AND WITHDRAWAL

7.1 DISCONTINUATION OF STUDY INTERVENTION

Early discontinuation from either FAB bar does not mean discontinuation from the study, and remaining study procedures should be completed as indicated by the study protocol. If a clinically significant finding is identified after enrollment, the PI or qualified designee will determine if any change in participant management is needed. Any new clinically relevant finding will be reported as an Adverse Event (AE).

7.2 PARTICIPANT DISCONTINUATION/ WITHDRAWAL FROM THE STUDY

Participants are free to withdraw from participation in the study at any time upon request. An Investigator may discontinue or withdraw a participant from the study for the following reasons:

- Withdrawal of informed consent (participant or parent/guardian withdraw for any reason)
- If any clinical Adverse Event (AE), laboratory abnormality, or other medical condition or situation occurs such that continued participation in the study would not be in the best interest of the participant.
- If the participant meets an exclusion criterion (either newly developed or not previously recognized) that precludes further study participation.

The reason for participant discontinuation or withdrawal from the study will be recorded in the study enrollment log. Patients who do not follow the prescribed bracing schedule will still be included in the study and recorded with the intention to treat principle. Similarly, if the DB prototype breaks or malfunctions and cannot be quickly repaired, the patient will return to their original SB but will not be withdrawn from the study.

Participants who sign the informed consent form, but do not return for study visits 1, 2 and/or 3 will be replaced. Participants who sign the informed consent form, and return for study visits 1, 2 and 3 but subsequently withdraw, or are withdrawn or discontinued from the study will not be replaced. The data from participants who are withdrawn or discontinued from the study will be used in the analysis unless the participant requests otherwise.

7.3 LOST TO FOLLOW-UP

All participants will be considered lost to follow-up if they fail to return for any one of the scheduled visits outlined in Section 1.3 and is unable to be contacted by the study site staff.

The following actions must be taken if a participant fails to return to the clinic for a required study visit:

- The site will attempt to contact the participant and reschedule the missed visit within the next 7 days and counsel the participant on the importance of maintaining the assigned visit schedule and ascertain if the participant wishes to and/or should continue in the study.
- Before a participant is deemed lost to follow-up, the Principal Investigator or designee will make every effort to regain contact with the participant (where possible, 3 telephone calls and, if necessary, a certified letter to the participant's last known mailing address or local equivalent methods). These contact attempts should be documented in the participant's medical record or study file.

- Should the participant continue to be unreachable, they will be considered to have withdrawn from the study with a primary reason of lost to follow-up.

8 STUDY ASSESSMENTS AND PROCEDURES

8.1 ASSESSMENTS

The physical exam that will be performed at each study visit will be done according to standard care for clubfoot. The only physical assessments that are not part of standard clubfoot care is measuring the patients' tibia length to ensure appropriate fit of the DB, as well as measuring the patients' height and weight to explore any possible reasons for bar malfunction or breakage. The height and weight of each participant will be measured and recorded by the blinded outcome assessor, with or without help of the clinic nurse, who routinely collects this data at SickKids.

To quantify parent perception and feedback, three different surveys will be administered to the parents/caregiver at scheduled times throughout the trial. This includes a survey at Day 0, Day 30, and Day 90 of the study period. Surveys will be completed in-person at the time of clinic visits, or via email after the visit if there was insufficient time to collect the data.

The purpose of the first survey on Day 0 is to assess parental perception of the SB prior to the study period. For the experimental arm, the second survey will assess parental perception of the new DB immediately after 30 days of wear, and the third survey will assess parental impression of returning to the SB after use of the DB at Day 90. For the control arm, the Day 30 and 90 surveys will serve as a test-retest reliability measure from Day 0 to assess if any variation over time (due to change in foot shape, treatment, recurrence, or environment) can be detected.

8.2 ADVERSE EVENTS AND SERIOUS ADVERSE EVENTS

8.2.1 DEFINITION OF ADVERSE EVENTS (AE)

An Adverse Event (AE) is any untoward medical occurrence associated with the use of an intervention in a study participant, which does not necessarily have a causal relationship with the intervention. An AE can therefore be any unfavourable and unintended sign, symptom or disease temporally associated with the use of the DB, whether or not considered related to the investigational intervention.

Stable chronic conditions which are present prior to entry in the study and do not worsen are not considered AE. These pre-existing conditions will be documented in the participant's medical history.

8.2.2 DEFINITION OF SERIOUS ADVERSE EVENTS (SAE)

AE are classified as serious or non-serious. A Serious Adverse Event is any AE that is:

1. fatal
2. life-threatening
3. requires or prolongs inpatient hospital stay
4. results in persistent or significant disability or incapacity
5. a congenital anomaly or birth defect
6. an important medical event

The term “life-threatening” in the definition of “serious” refers to an AE in which the participant was at risk of death at the time of the event. It does not refer to an AE that hypothetically might have caused death if it were more severe.

Important medical events are those that may not be immediately life threatening but are clearly of major clinical significance. They may jeopardize the participant and may require intervention to prevent one of the other serious outcomes noted above.

We do not foresee any SAEs occurring that are related to the use of the DB. That being said, all SEAs will be documented and reported for any incident that:

(a) is related to a failure of the dynamic bar or a deterioration in its effectiveness, or any inadequacy in its directions for use; and
(b) has led to the death or a serious deterioration in the state of health of a patient, user or other person, or could do so were it to recur. “Serious deterioration in the state of health” means: a life-threatening disease, disorder or abnormal physical state; the permanent impairment of a body function or permanent damage to a body structure; or a condition that necessitates an unexpected medical or surgical intervention to prevent such a disease, disorder or abnormal physical state or permanent impairment or damage.

8.2.3 ADVERSE EVENT REPORTING

Known risks associated with all standard bars include pressure sores, skin rashes, unintentional self-injuries, and clubfoot recurrence for suboptimal brace wear or application.

We anticipate that the same risks are associated with the dynamic bar prototype, in addition to the risk of bar malfunction or breakage due to lack of extensive material evaluations, and an increased risk of clubfoot recurrence due to the unprecedented mobility provided to patients.

If any of these events occur during the study, they will be documented in the patient’s chart, and on REDCap as specified by the Clubfoot Research Registry protocol. These events might also result in the participant being withdrawn from the study or temporarily discontinued from the study intervention.

It should be noted that pressure sores may break skin. While patients are encouraged to wear socks with their boots, if they choose to not wear socks, this may result in the ShearBan adhesive, which will be placed on top of the temperature sensor inside the boot, coming into contact with intact or non-intact skin.

8.2.4 CLASSIFICATION OF AN ADVERSE EVENT

8.2.4.1 SEVERITY OF EVENT

The severity of an AE will be assessed by a blinded outcomes assessor, physiotherapist Barbara Harvey, and/or the PI. They will use the following definitions when assessing the intensity of an AE:

- **Mild** – Events require minimal or no treatment and do not interfere with the participant’s daily activities.
- **Moderate** – Events result in a low level of inconvenience or concern with the therapeutic measures. Moderate events may cause some interference with functioning.

- **Severe** – Events interrupt a participant's usual daily activity and may require systemic drug therapy or other treatment. Severe events are usually potentially life-threatening or incapacitating. Of note, the term "severe" does not necessarily equate to "serious".

The only "severe" AE that is foreseen to potentially occur during the study is clubfoot recurrence. Clubfoot recurrence would likely be treated by serial casting, as is standard care for clubfoot treatment. Mild to moderate AEs may potentially include pressure sores, skin rashes, and unintentional self-injuries. All of these AEs are known risks associated with FABs.

8.2.4.2 RELATIONSHIP TO DYNAMIC BAR OR STANDARD BAR

All Adverse Events (AEs) will have their relationship to the DB or SB assessed by the blinded outcomes assessor, physiotherapist Barbara Harvey, and/or the PI, based on temporal relationship and their clinical judgment. The degree of certainty about causality will be graded using the categories below.

- **Definitely Related** – There is clear evidence to suggest a causal relationship, and other possible contributing factors can be ruled out. The clinical event occurs in a plausible time relationship to study intervention administration and cannot be explained by concurrent disease or other drugs or chemicals. The response to withdrawal of the study intervention should be clinically plausible.
- **Probably Related** – There is evidence to suggest a causal relationship, and the influence of other factors is unlikely. The clinical event occurs within a reasonable time after administration of the study intervention, is unlikely to be attributed to concurrent disease or other drugs or chemicals, and follows a clinically reasonable response on withdrawal.
- **Possibly Related** – There is some evidence to suggest a causal relationship (e.g., the event occurred within a reasonable time after administration of the study intervention). However, other factors may have contributed to the event (e.g., the participant's clinical condition, other concomitant events).
- **Unlikely to be related** – A clinical event whose temporal relationship to study intervention administration makes a causal relationship improbable (e.g., the event did not occur within a reasonable time after administration of the study intervention) and in which other drugs or chemicals or underlying disease provides plausible explanations (e.g., the participant's clinical condition, other concomitant treatments).
- **Unrelated** – The AE is completely independent of study intervention administration, and/or evidence exists that the event is definitely related to another etiology.

8.2.4.3 EXPECTEDNESS

The blinded outcomes assessor, physiotherapist Barbara Harvey, and/or the PI, will be responsible for determining whether an Adverse Event (AE) is expected or unexpected. An AE will be considered unexpected if the nature, severity, or frequency of the event is not consistent with the risk information previously described for the study intervention.

All unexpected AEs will be reported to The Hospital for Sick Children Research Ethics Board according to The Hospital for Sick Children's Adverse Event Reporting Requirements.

8.2.5 TIME PERIOD AND FREQUENCY FOR EVENT ASSESSMENT AND FOLLOW-UP

All AEs and SAEs occurring while on study will be documented regardless of relationship. Information to be collected will include event description, date of onset, date of resolution, outcome, and the assessment of seriousness, expectedness, relationship to study intervention, and severity.

Any baseline condition recorded in the medical history that deteriorates at any time during the study, will be recorded as an AE or SAE.

Changes in the severity of an AE will be documented to allow an assessment of the duration of the event at each level of severity to be performed.

Events will be followed for outcome information until resolution or in the opinion of the blinded outcomes assessor, physiotherapist Barbara Harvey, and/or the PI, the participant is stable and does not require further follow-up, or the participant is deemed lost to follow-up.

8.2.6 REPORTING EVENTS TO PARTICIPANTS

Participants and/or their parent/legal guardian will be informed in a timely manner of any new information, including safety information, that is relevant to that participant's willingness to continue participation. The communication of this information will be documented through a revised REB approved Informed Consent Form, where possible, based on the timeliness of the information.

9 STATISTICAL CONSIDERATIONS

9.1 SAMPLE SIZE DETERMINATION

The intent of this study is to obtain preliminary data on the current prototype and evaluate the feasibility of conducting a larger-scale clinical trial. Therefore, only a minimum of 10 patients will be enrolled in each arm.

In a future effectiveness randomized controlled trial, we plan to use a sample size of 124, with 62 patients per arm. This sample size will ensure that the study has sufficient statistical power to detect a minimal clinically detectable difference in recurrence rates of at least 20% between the SB and DB group. Note this is assuming that the recurrence rates in the control arm will be 30%, as reported recurrence rates after correction range from 20-41% (6). This power analysis was conducted based on 80% power and 5% type 1 error.

The Clubfoot Clinic at SickKids sees approximately 35 patients per week. Based on the frequency of clinical visits required for patients at different stages in the Ponseti treatment, it is expected that approximately 15% of these patients will be between the ages of 1 and 3 and in the minimum 12-hour per day bracing stage of the Ponseti treatment. Furthermore, approximately 80% of all clubfoot patients are idiopathic, and it is expected that 75% of eligible patients will be willing to participate in the trial (22). Therefore, it is foreseen that it will take approximately 2 months to register all 20 participants.

9.2 POPULATIONS FOR ANALYSES

The following study populations are defined and will be analyzed as specified below:

- Intent to treat population: the total population of patients registered in the study.
- Experimental arm population: all registered participants in the experimental arm with DB.
- Control arm population: all registered participants in the control arm with SB.

- Safety population: all registered participants who wore their FAB as prescribed for the full 90-day study period.

- Brace discomfort population: all registered participants who have any history of brace intolerance or indicated in the parent-reported survey that they are not comfortable/have concerns with their original FAB.

- Brace comfort population: all registered participants who have no history of brace intolerance and indicated in the parent-reported survey that they are comfortable/have no concerns with their original FAB.

9.3 STATISTICAL ANALYSES

9.3.1 GENERAL APPROACH

All data will be deidentified before analysis. Due to the small sample size, the analysis will consist of descriptive statistics, as defined in terms of means, standard deviations, and percentile ranks where applicable.

9.3.2 ANALYSIS OF THE PRIMARY ENDPOINT

To identify potential barriers in recruiting patients/parents for a larger-scale clinical trial to evaluate the effectiveness of the DB, questions in the parent-reported surveys will ask about the parents' perspectives regarding joining a future study. The enrollment log will also include patients who do not wish to participate in the study and their reason(s) for refusal/withdrawal. Descriptive statistics will be used to analyze the recruitment rate, dropout rate, and related responses on the parent-reported survey for the intent to treat population, the experimental arm population, and the control arm population.

The enrollment log will also record the age and fit issues of patients that do not adequately fit the available prototype but are otherwise eligible. This will serve to inform future adaptations of the new DB for future trials.

9.3.3 ANALYSIS OF THE SECONDARY ENDPOINTS

Parent-reported comfort levels will be determined by parent-reported surveys with 5-point Likert scale responses. Results from these surveys will be analyzed with descriptive statistics for the intent to treat population, the brace discomfort population, and the brace comfort population.

Daily bracing times will be measured by a temperature sensor added in each patient's boots for the entire 90-day study period. The number of hours the brace is worn per day will be divided by the standard number of desirable hours in brace (12 hours) in order to obtain a fraction that quantifies the patient's adherence to the FAB. Mean 'adherence fractions' will be calculated for patients in each arm, and then compared using descriptive statistics. This analysis will be performed for the intent to treat population, the brace discomfort population, and the brace comfort population. This data will be compared to the self-reported brace wear hours by parents in their daily logs.

To ensure minimal efficacy of the DB prototype, all signs of clubfoot recurrence will be carefully examined at each study visit. The null hypothesis is that 'the dynamic bar does not lead to higher rates

of clubfoot recurrence,' and it will be rejected if the number of patients in the safety population that develop clubfoot recurrence during the 90-day study period, is substantially greater in the experimental arm than it is in the control arm (i.e. more than 2 instances of clubfoot recurrence in the experimental arm than in the control arm). Note that this endpoint is not intended to prove safety or efficacy, but rather to ensure that the design may prevent early recurrence before a larger-scale trial is conducted. Clubfoot recurrence is defined as a Pirani score > 0.5, a new occurrence of cavus, adduction and/or hindfoot varus, or a loss of passive ankle dorsiflexion (equinus) of < 10 degrees above neutral or a reduction of 5 or more degrees from the previous visit. Note that all clinical tests required to diagnose recurrence are routinely performed as standard clubfoot care.

If consent is provided by the parents, a member of the study team will also record a video of each patient wearing their prescribed bar on Day 30 of the study period. These videos will be closely studied to compare the range of motion provided by the SB to the DB, and to verify that the DB consistently maintains proper foot position during use. Videos will be recorded on a password-protected personal device, audio will be removed, then the video will be uploaded each day to the patient's REDCap forms. The video will then be deleted from the personal device. All efforts will be made to made to only include the patient's feet and legs in the field of the video, and to blur or remove any identifiable physical marks like unique birthmarks and tattoos on the patient's skin.

10 SUPPORTING DOCUMENTATION AND OPERATIONAL CONSIDERATIONS

10.1 REGULATORY, ETHICAL, AND STUDY OVERSIGHT CONSIDERATIONS

10.1.1 STUDY DISCONTINUATION AND CLOSURE

This study may be temporarily suspended or prematurely terminated if there is sufficient reasonable cause. Written notification, documenting the reason for study suspension or termination, will be provided by the suspending or terminating party to study participants and the REB. Study participants will be contacted, as applicable, and be informed of changes to study visit schedule.

Circumstances that may warrant termination or suspension include, but are not limited to:

- Determination of unexpected, significant, or unacceptable risk to participants by use of the dynamic bar
- Insufficient compliance to protocol requirements
- Data that are not sufficiently complete and/or evaluable

The study may resume once concerns about safety, protocol compliance, and data quality are addressed, and satisfy the Sponsor and REB.

10.1.2 CONFIDENTIALITY AND PRIVACY

All research activities will be conducted in as private a setting as possible.

Study data will be entered into REDCap, a secure, web-based application designed exclusively to support data capture for research studies. The application and data are housed on servers provided by the Hospital for Sick Children. These servers are located within SickKids secure data center.

Most patient health information that will be analyzed for this trial will be collected, stored, and destroyed as specified by the Clubfoot Research Registry (REB #1000053919). The clinical evaluations performed at each study visit will be standard care.

A separate electronic enrollment log will track enrollment of patients by MRN number and name and assign a study ID to those patients that consent to participate in the trial. Data collected will not link to participants' OHIP number.

Patient confidentiality will be ensured except when legally required. Only members of the research team will have access to the research data. Any data exported for statistical analysis will be de-identified. All identifying information will be kept behind 2 security measures or as per equivalent institutional policy, under the supervision of the PI and will not be transferred outside of the hospital.

To enable evaluations and/or audits from the Sponsor or REB, the Principal Investigator agrees to keep records, including all original signed informed consent forms, consent discussion forms, the enrollment log, and surveys in a secure location for a minimum of 7 years in accordance with SickKids policy. Subsequently, all identifying data will be destroyed.

10.1.3 KEY ROLES AND STUDY GOVERNANCE

Principal Investigator
Dr. Maryse Bouchard
The Hospital for Sick Children
555 University Ave, Toronto, ON M5G 1X8
416-813-7654
maryse.bouchard@sickkids.ca

The principal investigator will supervise the overall administration, maintenance, and monitoring of the trial. If the Principal Investigator relocates, retires, or for any reason withdraws from the study, then the study will be discontinued.

Barbara Harvey is an advanced practice physiotherapist, who will work with the PI to monitor patients throughout the trial. This will include monitoring brace fit during the intervention period.

The outcomes assessor is also an advanced practice physiotherapist, who will be responsible for conducting the clinical examinations on each participant, and monitoring brace fit on Day 90 of the study period (once all participants have returned to their original standard bar). This physiotherapist will be independent of the study team and blinded from which bar is prescribed to reduce bias in clinical assessments.

Other study team roles include a research coordinator and research assistant, who will be responsible for screening and consenting participants, checking the patients into rooms at the beginning of each visit to protect the outcomes assessor's blind, administering surveys, documenting, and analyzing data.

10.1.4 SAFETY OVERSIGHT

Safety oversight will be under the direction of a Data Safety Monitoring Board (DSMB) composed of individuals with the appropriate expertise, including a pediatric orthopaedic surgeon who is familiar with clubfoot treatment. Members of the DSMB will be independent from the study conduct. The DSMB will meet one time during the 90-day study period to assess safety and efficacy data on each arm of the study. The DMSB will operate under the rules of an approved charter that will be reviewed at the

organizational meeting of the DSMB. At this time, each data element that the DSMB needs to assess will be clearly defined. The DSMB will provide its input to the Hospital for Sick Children.

10.1.5 PROTOCOL DEVIATIONS

A protocol deviation is any noncompliance with the clinical trial protocol. The Principal Investigator will assure that no deviation from, or changes to the protocol will take place without prior agreement from the Sponsor and documented approval from the Research Ethics Board (REB), except where necessary to eliminate an immediate hazard(s) to the trial participants. The noncompliance may be either on the part of the participant, the Investigator, or the study site staff. As a result of deviations, corrective actions are to be developed by the site and implemented promptly. All protocol deviations will be documented; the Principal Investigator will assess each protocol deviation to determine the impact to the patient's rights, safety or welfare, study efficacy and data integrity.

It is the responsibility of the Principal Investigator to use continuous vigilance to identify and report deviations within 10 working days of identification of the protocol deviation, or within 10 working days of the scheduled protocol-required activity. All deviations must be addressed in study source documents and reported to the Sponsor. Protocol deviations must be sent to the reviewing REB in accordance with their policies. The Principal Investigator is responsible for knowing and adhering to the reviewing REB requirements.

10.1.6 CONFLICT OF INTEREST POLICY

There is a conflict of interest wherein the PI and co-investigators of this study are the inventors of the dynamic bar, and so they might wish to sell the bar in the future for profit. This conflict of interest will be mitigated by relying on unbiased quantitative evaluations done by blinded outcomes assessors in order to assess the study's endpoints.

There is also a potential pre-existing health care provider-patient relationship between members of the care team and the participant. However, this potential conflict of interest will be mitigated through exclusion of the circle of care team from the informed consent process. The research assistant and/or research coordinator will be responsible for obtaining informed consent.

10.2 ABBREVIATIONS

AE	Adverse Event
DB	Dynamic Bar
DSMB	Data Safety Monitoring Board
FAB	Foot Abduction Brace
GCP	Good Clinical Practice
ICH	International Council on Harmonisation
NIST	National Institute of Standards and Technology
PI	Principal Investigator
REB	Research Ethics Board
REDCap	Research Electronic Data Capture
SAE	Serious Adverse Event
SB	Standard Bar
SoA	Schedule of Activities

11 REFERENCES

(1) Anand A, Sala DA. Clubfoot: etiology and treatment. Indian J Orthop. 2008 Jan;42(1):22-8.

(2) Hospital for Special Surgery [Internet]. New York: HSS. Method for Correcting Clubfoot: Overview for Parent; 2019 Sept 12 [cited 2021 Jan 11] Available from: https://www.hss.edu/conditions_thse-ponseti-method-for-clubfoot-correction.asp.

(3) Alves C. Bracing in clubfoot: do we know enough?. Journal of Children's Orthopaedics. 2019 Jun 1; 13(3):258–264.

(4) Garg S, Porter K. Improved bracing compliance in children with clubfeet using a dynamic orthosis. Journal of Children's Orthopaedics. 2009 Jun 3; 3(4):271–276.

(5) SickKids Internal Document. CLUBFOOT FAO BAR OPTIONS June 2017 edited. 2017 June.

(6) Azarpira MR, Emami MJ, Vosoughi AR, Rahbari K. Factors associated with recurrence of clubfoot treated by the Ponseti method. World J Clin Cases. 2016 Oct 16; 4(10):318-322.

(7) Zhao D, Liu J, Zhao L, Wu Z. Relapse of clubfoot after treatment with the Ponseti method and the function of the foot abduction orthosis. Clinics in orthopedic surgery. 2014 Sept; 6(3): 245–252.

(8) American Academy of Orthopaedic Surgeons [Internet]. Illinois: AAOS. Study Finds Ponseti Method Remains an Effective Treatment for Clubfoot, Bracing Is Paramount; 2021 Jan 18 [cited 2021 May 25] Available from: https://www.aaos.org/aaosnow/2020/aaos-now-special-edition/research/662_pediatrics.

(9) Gelfer Y, Wientroub S, Hughes K, Fontalis A, Eastwood DM. Congenital talipes equinovarus: a systematic review of relapse as a primary outcome of the Ponseti method. Bone Joint J. 2019 Jun; 101-B(6):639-645.

(10) Morgenstein A, Davis R, Talwalkar V, Iwinski H Jr, Walker J, Milbrandt TA. A randomized clinical trial comparing reported and measured wear rates in clubfoot bracing using a novel pressure sensor. J Pediatr Orthop. 2015 Mar;35(2):185-91.

(11) Aroojis A, Pandey T, Dusa A, Krishnan AG, Ghyar R, Ravi B. Development of a functional prototype of a SMART (Sensor-integrated for Monitoring And Remote Tracking) foot abduction brace for clubfoot treatment: a pre-clinical evaluation. Int Orthop. 2021 Apr 22:1–10.

(12) Sangiorgio SN, Ho NC, Morgan RD, Ebramzadeh E, Zionts LE. The Objective Measurement of Brace-Use Adherence in the Treatment of Idiopathic Clubfoot. J Bone Joint Surg Am. 2016 Oct 5;98(19):1598-1605.

(13) Masrouha KZ, Moses MJ, Sala DA, Litrenta J, Lehman WB, Chu A. The Validity of Patient-reported Outcome Measurement Information System (PROMIS) Parent Proxy Instruments to Assess Function in Children With Talipes Equinovarus. J Pediatr Orthop. 2019 Nov/Dec;39(10):e787-e790.

(14) Varni JW, Limbers CA, Burwinkle TM. Parent proxy-report of their children's health-related quality of life: an analysis of 13,878 parents' reliability and validity across age subgroups using the PedsQL 4.0 Generic Core Scales. Health Qual Life Outcomes. 2007 Jan 3;5:2.

(15) Mitchell JR, inventor. Quick clip for a club foot device. United States patent US 20160113803A1. 2002 Jun 9.

(16) C-Pro Direct [Internet]. Ponseti AFO Standard Sandals with Bar; [cited 2021 May 25] Available from: https://c-prodirect.com/ponseti-afo-standard-sandals-with-bar.

(17) MD Orthopaedics [Internet]. Massachusetts: MD Orthopaedics. Ponseti® Bar; [cited 2021 May 25] Available from: https://mdorthopaedics.easyordershop.com/link/en/bars/ponseti/a/.

(18) iButtonLink Technology [Internet]. DS1922L-F5# Thermochron iButton 8K -40 to 85°C; [cited 2021 July 1] Available from: https://www.ibuttonlink.com/products/ds1922l.

(19) Dobbs MB, Frick SL, Mosca VS, Raney E, VanBosse HJ, Lerman JA, Talwalkar VR, Steger-May K, Gurnett CA. Design and descriptive data of the randomized Clubfoot Foot Abduction Brace Length of Treatment Study (FAB24). J Pediatr Orthop B. 2017 Mar;26(2):101-107.

(20) Tamarack Habilitation Technologies, Inc. [Internet] ShearBan® Self-Adhesive, Low-Friction Sheets for Foot Blister and Ulcer Care; [cited 2021 August 2] Available from: https://tamarackhti.com/resources/shearban/

(21) Youtube [Internet]. Installing I-Button in Ponseti AFO; [cited 2021 July 1] Available from: https://www.youtube.com/watch?v=YACSbFn-lOA.

(22) Sadler B, Gurnett C, Dobbs M. The genetics of isolated and syndromic clubfoot. Journal of Children's Orthopaedics. 2019 Jun 1; 13(3):238-244.

(23) D-Bar Enterprises [Internet]. Missouri: D-Bar Enterprises. Product Guide and Catalog ® Bar; 2015 [cited 2021 May 27] Available from: https://www.dobbsbrace.com/products.

12 APPENDIX A: IMAGES OF FOOT ABDUCTIONS BARS

Figure 1: Standard Dobbs Bar (23)

Figure 2: Standard Ponseti Straight Bar with “Quick Clip” mechanism (16,17).

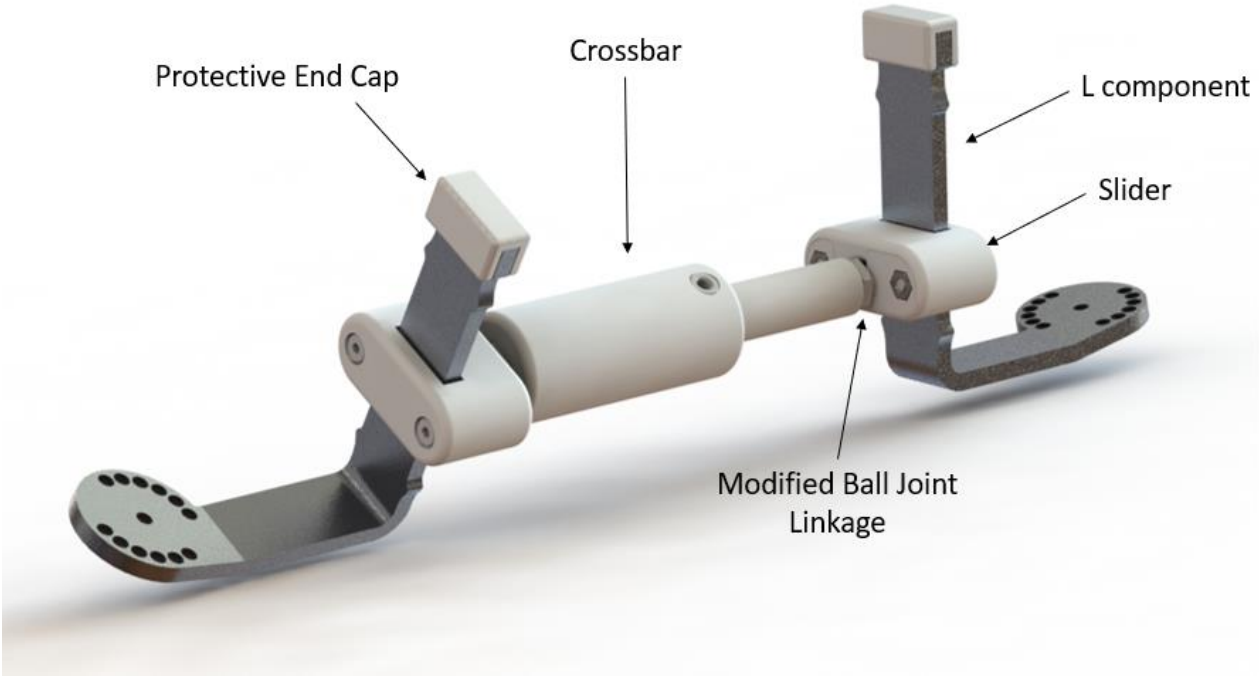
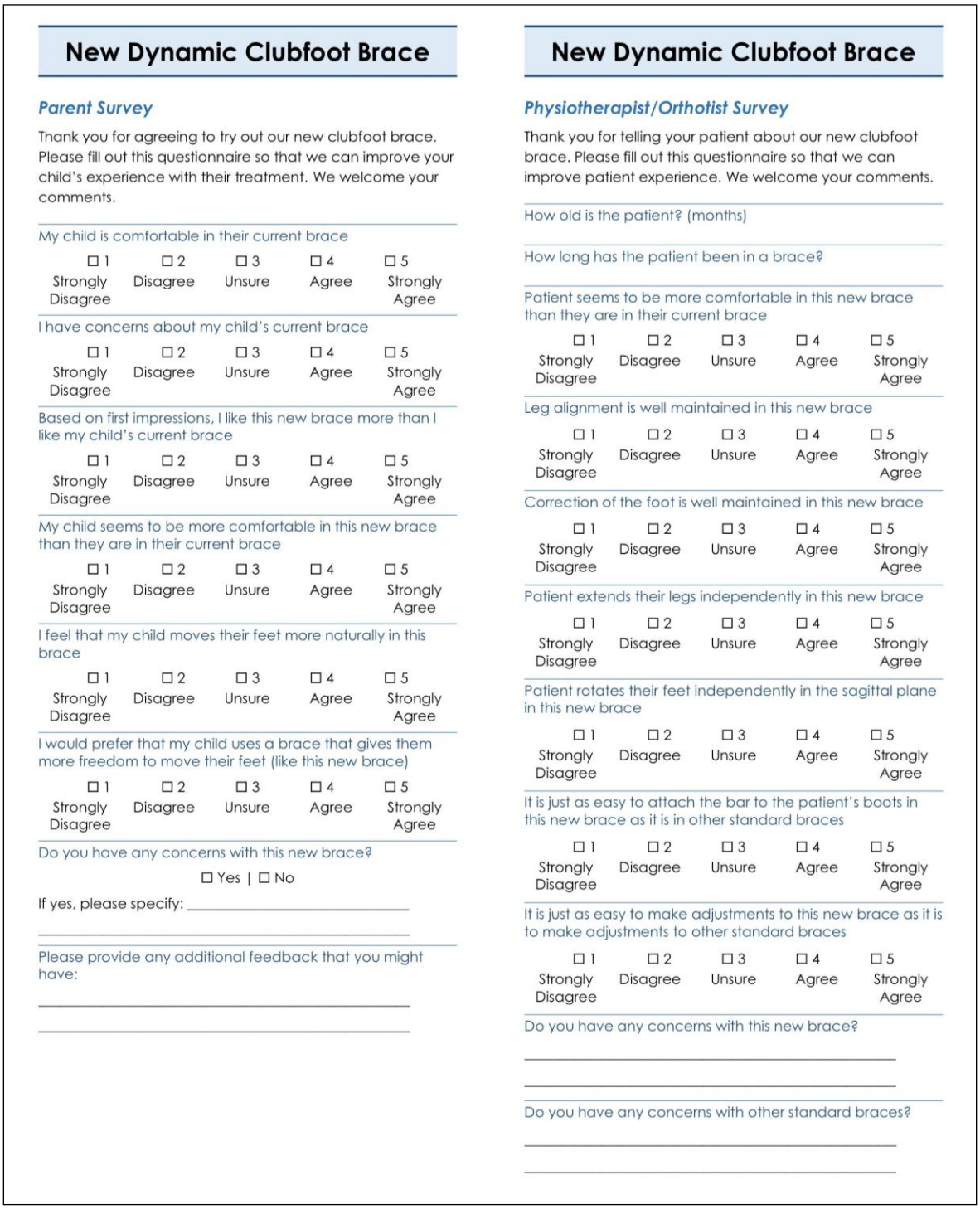


Figure 3: Novel Dynamic Bar Prototype.

13 APPENDIX B: SURVEYS USED IN INITIAL EVALUATION



New Dynamic Clubfoot Brace

Parent Survey

Thank you for agreeing to try out our new clubfoot brace. Please fill out this questionnaire so that we can improve your child's experience with their treatment. We welcome your comments.

My child is comfortable in their current brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

I have concerns about my child's current brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Based on first impressions, I like this new brace more than I like my child's current brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

My child seems to be more comfortable in this new brace than they are in their current brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

I feel that my child moves their feet more naturally in this brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

I would prefer that my child uses a brace that gives them more freedom to move their feet (like this new brace)

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Do you have any concerns with this new brace?

☐ Yes | ☐ No

If yes, please specify: _____

_____

Please provide any additional feedback that you might have:

_____

_____

New Dynamic Clubfoot Brace

Physiotherapist/Orthotist Survey

Thank you for telling your patient about our new clubfoot brace. Please fill out this questionnaire so that we can improve patient experience. We welcome your comments.

How old is the patient? (months)

How long has the patient been in a brace?

Patient seems to be more comfortable in this new brace than they are in their current brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Leg alignment is well maintained in this new brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Correction of the foot is well maintained in this new brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Patient extends their legs independently in this new brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Patient rotates their feet independently in the sagittal plane in this new brace

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

It is just as easy to attach the bar to the patient's boots in this new brace as it is in other standard braces

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

It is just as easy to make adjustments to this new brace as it is to make adjustments to other standard braces

☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Unsure ☐ 4 Agree ☐ 5 Strongly Agree

Do you have any concerns with this new brace?

_____

_____

Do you have any concerns with other standard braces?

_____

_____

Figure 4: Surveys administered in the initial, informal evaluation of the dynamic bar.