

PRoF Award abstract – Call 2018

Holistic Perioperative Healthcare Model for children undergoing pectus surgery

**Implementing an innovative individualized care programme to
optimize rehabilitation and reduce persistent pain**

1. Research Outline

Acronym	HERALD
Project name in English	Holistic Perioperative Healthcare Model for children and adolescents undergoing pectus surgery: Implementing an innovative, individualized and fully integrated care pathway to optimize postoperative healing by reducing acute pain, preventing pain chronification, accelerating recovery and reducing school absenteeism.
Pitch (1 sentence)	The implementation of HERALD will provide an integrated and comprehensive perioperative management eHealth programme for patients undergoing pectus surgery.
Executive summary (max. 10 lines)	
<p>This project consists of the implementation of a biopsychosocial multidisciplinary perioperative care programme that will optimize individual pain management, enhance recovery, and increase the health-related quality of life after major thoracic surgery. The resulting higher quality of perioperative care positively affects all measurable objective outcome parameters during hospitalization, including the capacity for deep breathing, the ability to move, the length of the hospital stay and rehabilitation, as well as overall satisfaction. Moreover, the development of this care pathway combines the knowledge of mental healthcare workers, physiotherapists, surgeons, anaesthesiologists and pain specialists by offering a readily usable unique platform for (long-term) patient follow-up, which can decrease pain chronification.</p>	

2. Cause and context of the research

Introduction

Thorax wall deformity occurs in 1 out of 400 to 1000 children. Many of these children experience aesthetic hurdles in addition to compromised self-esteem during the vulnerable phase of puberty. Surgery is more often planned for aesthetic reasons than as a necessary correction due to compression of underlying organs. Although minimally invasive correction (MIPC) has become common practice, it still remains associated with severe postoperative pain. Moreover, the intensity of postoperative pain following MIPC has been shown to be the overriding factor in the patient's perception of quality of life during the postoperative period. In addition to challenging pain reduction strategies, many investigators have shown that preoperative psychosocial factors such as anxiety further decrease well-being after surgery. Furthermore, patients undergoing thoracic surgery are likely to develop persistent postoperative pain after surgery; this pain is often neuropathic and therefore more difficult to treat (i.e., pain chronification).

Problem identification

Despite the recently increasing scientific interest in pain management after major surgery in children, the provision of adequate pain treatment still remains a universal challenge for healthcare providers. Furthermore, little research has been done to evaluate (persistent) pain and related outcomes during the entire postoperative follow-up period in children undergoing major surgery. We do know that untreated acute pain is far from benign, with both short- and long-term adverse effects. Data are not yet available on the precise incidence of persistent postsurgical pain (PPSP) in children as reported by studies in adults. To elucidate PPSP, physicians will have to monitor patients at least 3 months. PPSP rates of 10-80% have been reported in adults for a variety of surgical procedures (Martinez et al. 2013). Recently, researchers documented a prevalence of persistent pain after surgery of 20% at 12 months after the noxious insult (Williams et al.). Patients undergoing thoracic or spinal fusion surgery have a significantly higher risk of PPSP if high pain scores are experienced immediately postoperatively.

Ongoing pain can lead to significant suffering, functional disability and work/school absenteeism for the young individual *and* for family members. Although the mechanisms underlying the development of pain chronification are not fully elucidated in adults, a number of risk factors have been identified, including age, site of surgery, risk of nerve damage, and psychological factors (Martinez et al. 2013).

By implementing an innovative biopsychosocial perioperative care programme, we aim to optimize pain management and health-related quality of life of patients undergoing pectus surgery. The resulting higher quality of perioperative care could positively affect all measurable objective outcome parameters during hospitalization, including the capacity for

deep breathing, the ability to move, the ability to eat, and the length of the hospital stay (LOS) as well as overall satisfaction. Furthermore, this healthcare model can be easily extrapolated to other surgical specialties.

Considering all of the abovementioned arguments, there is an explicit need for improving outcome and preventing persistent pain after major surgery, especially in vulnerable young patients.

The proposed approach aims to optimize the rehabilitation process during the early and long-term postoperative phases by implementing a standardized perioperative pain management programme. The prevention and treatment of PPSP involves the creation of an individualized management plan that includes biopsychosocial care and the use of multidisciplinary interventions when necessary.

Furthermore, we introduce and evaluate the usefulness of e-health technology in surgical care. Appi@Home (Antwerp Personalized Pain Initiative) supports an innovative approach by offering a platform for online questionnaires and telemonitoring devices such as activity trackers, sleep monitors, blood pressure measuring devices and by giving the healthcare professional more objective real-time data after hospitalization. Moreover, the easily accessible online platform and telemonitoring devices can be used at patient-selected times and locations, thereby supporting self-management. This promising approach may decrease patient dropout and may significantly shorten the interval between surgery and the reporting of pain, which is a necessary occurrence for prompt, adequate treatment.

3. Innovation results achieved

Tools: PectusBoek & Appi@Home internet platform and toolbox

In-hospital registration of multidisciplinary pain scores, postoperative nausea and vomiting, subjective sleep quality and respiratory rehabilitation after thoracic wall surgery is conducted via a **specially designed multidisciplinary registration tool** (PectusBoek, *Figure 1*).

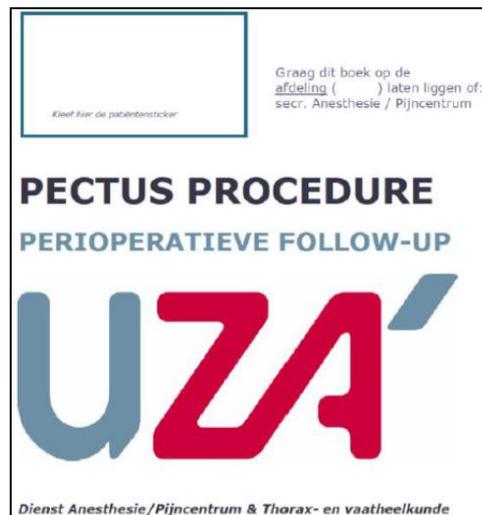


Figure 1. PectusBoek, a tool used for multidisciplinary registration of patient rehabilitation immediately following surgery

Rehabilitation is measured as an overall holistic outcome parameter involving all facets of recovery after surgery. The measurement specifications are summarized in Table 1 (data derived from our pilot phase study, N=29). Figure 2 shows the pain scores during hospitalization on an 11-level scale; a score of 0 is defined as no pain, and 10 indicates maximal pain intensity.

Table 1. Overview of main outcome parameters (preliminary results)

Outcome parameters	Before HERALD*	Applying HERALD
Days of bladder catheterization	6.42 ± 1.98	3.41 ± 1.50
Days of epidural analgesia	5.32 ± 1.06	5.83 ± 0.89
Revalidation: mobility	Not quantitatively registered	Standing Day 1: not allowed Day 2: 27% Day 3: 65% Day 4: 76% Walking Day 1 & 2: not allowed Day 3: 27% Day 4: 56%
Revalidation: Flow-oriented incentive spirometry	Not quantitatively registered	Day 1: 63% Day 2: 92% Day 3: 100%
Length of hospital stay (days)	7.32 ± 1.34	6.62 ± 1.97 **
Persistent pain after 10 weeks†	Not quantitatively registered	36.4%, whereof: NRS <3: 27.2% NRS ≥3: 9%

* Data from the year 2016 (N=19), before implementation of the HERALD care pathway

** Patients could be discharged after six days (before implementation vs. with programme, P=0.19) but left the hospital on a later day (7.66 ± 2.01 days) due to practical considerations.

† Incomplete data (5 patients are still monitored in the postoperative period)

NRS: 11-level pain score, Numeric Rating Scale

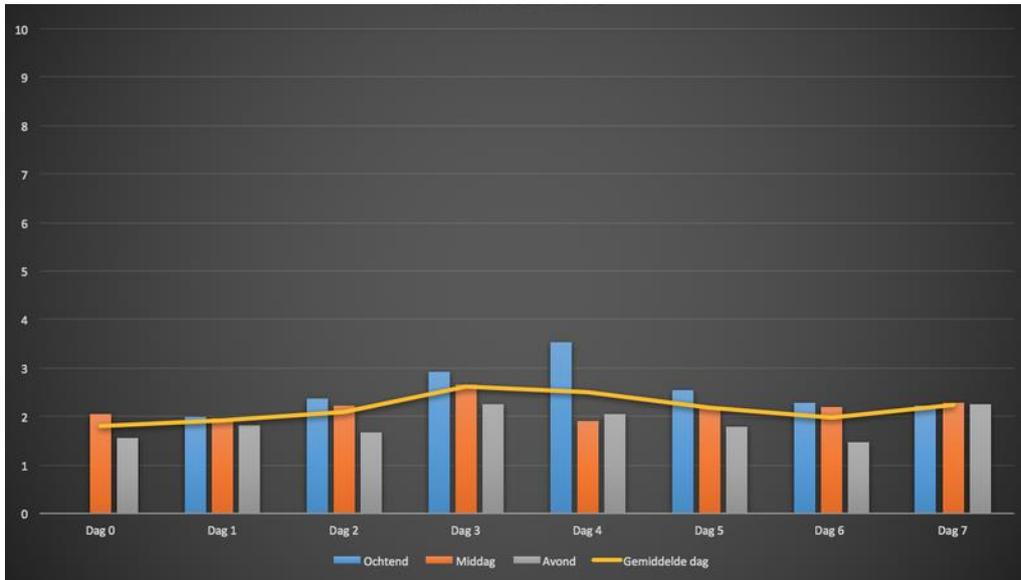


Figure 2. Mean pain scores derived from HERALD patient data from the day of surgery (Day 0) to 1 week after surgery, measured 3 times per day. The yellow line shows the mean pain score for each day. A score ≥ 3 indicates that pain reduction (analgesic) intervention is necessary.

The **Appi@Home e/mHealth technology** (Figure 3) encompasses an **internet platform** consisting of preoperative screening for psychological confounders (yellow flags such as anxiety and depression, self-esteem evaluation, and coping strategies) through easily accessible and adjustable online questionnaires **and a corresponding toolbox with a diary**. The platform provides unique information for both the patient and the caregiver via patient- or procedure-specific activated questionnaires, measures objective parameters via platform-linked devices, generates Hector-secured data and includes a patient diary in which updates concerning pain, sleep and daily activity are noted. Patients are asked to take measurements on a daily basis for up to 3 months after surgery (threshold definition of PPSP).



Figure 3. Appi@Home toolbox with medical grade telemetric devices (not limitative)

Although MIPC is considered a minimally invasive procedure, corrective surgery is a major clinical event in the life of most patients and has a long and often problematic rehabilitation period of months, which is not infrequently accompanied by impaired reintegration due to PPSP. The use of e-Health technology makes a more intensive and longer follow-up possible, which would not be feasible with 'classical', more demanding follow-up methods, during this rehabilitation period. The semi-objective eDiary information is greatly enhanced by the objective and functional data captured by the non-invasive medical grade monitoring devices (telemetry), offering continuous insight into the global functioning of the patient and providing real-time objective outcome parameters. Blood pressure and heart rate are continuously monitored as functional parameters for assessing the physical condition of the patient and the rehabilitation process, sleep characteristics are monitored with a telemetric device, oxygen saturation is repeatedly measured with a finger probe and daily motion is continuously recorded via a Bluetooth-operated medical-grade activity tracker. Participants are asked to fill in the online diary via smartphone (Appi@Home app) or the online platform (<https://appi.uza.be>) on a daily basis for up to 3 months after surgery. eDiary assessments include pain score (NRS), subjective sleep score and a score of the patient's ability to execute allowed activities. All scores are rated on an 11-point scale from 0 (no pain, poor sleep, poor activity execution) to 10 (worst pain, optimal sleep, good activity execution).

At the end of the study period, patients were asked to score their satisfaction with the executed overall care (Figure 4) at a final closing interview. Nevertheless, long-term cost efficiency results are not available.

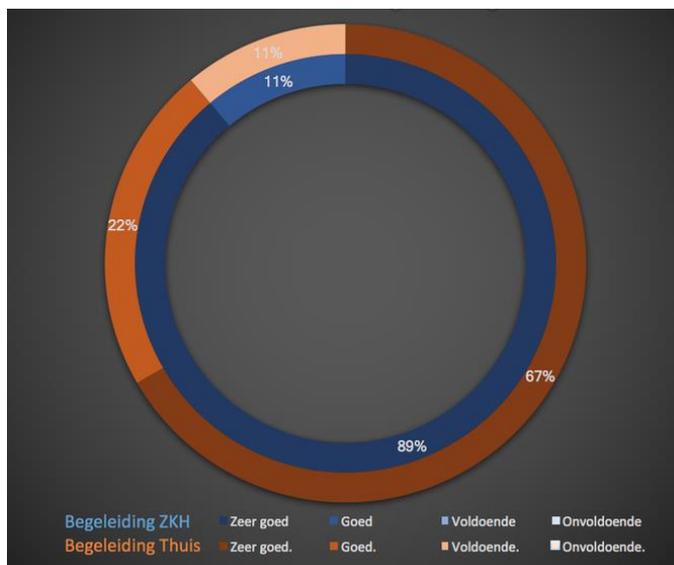


Figure 4. Overall patient satisfaction. Blue: in-hospital setting, red: follow-up after hospital discharge. Satisfaction was scored on a 4-level scale. Darker colours indicate greater patient satisfaction. No patient scored the follow-up as poor.

Our proof-of-concept study was performed in the summer of 2017 (data shown above) as a collaboration between the Departments of Anaesthesiology, Multidisciplinary Pain Center (MPC), Thoracic Surgery and Paediatrics (Antwerp University Hospital (UZA), University of Antwerp (UA)) and BeWell Innovations NV.

4. Link to the PRoF values

Here, we illustrate the need for and the added values of a multidisciplinary perioperative care pathway and link this model to the PRoF values:

Comfort. Advanced perioperative care, even after patients are discharged from the hospital following an intensive postoperative phase, can dramatically increase patients' quality of life. Moreover, the routine implementation of a biopsychosocial perioperative care pathway can also prevent pain chronification. A personalized approach can also determine risk factors and persisting pain symptoms, which can be adequately treated in an early phase. Follow-up via flexible telemonitoring devices and dynamic questionnaires is easily accessible, giving the clinician the possibility of a structured objective patient monitoring process supplemented with more subjective patient experiences.

Privacy & Security. The Appi@Home system links a unique identification number to individual users, whose profiles are structured in profile types (example: type of surgery). Patient authentication is required during the first login procedure. The patient data retrieved from the telemetric monitoring devices are protected similarly to the patient data in an electronic medical patient file in the hospital. All measurements are saved at the UZA data centre. Only authorized staff can consult these data. Furthermore, patient personal privacy is guaranteed because patients can use the devices at a time and location of their choosing as long as internet and Bluetooth connectivity are available for connection with the linked smartphone.

Anti-loneliness. The improvement of (long-term) perioperative care by an individual management strategy can positively affect self-esteem and self-assurance. Moreover, patients become active participants in this global approach. Therefore, patients can reintegrate and participate in normal social activities early in the recovery process.

Non-stigmatising solutions. Hospital discharge after major surgery is often accompanied by the emergence of new questions. Via the platform, every patient can easily contact a specialized team member with any questions regarding the operation, medication or pain symptoms. This care model is intended to enhance recovery and the resumption of a social life (school/work, hobbies, etc.) on a long-term basis after major surgery.

Intergenerational. The implementation of this perioperative care model not only is applicable for children and adolescents undergoing (major) surgery but also can be extrapolated to adults undergoing any type of surgery. With the Appi@Home application, family members can be involved in the whole rehabilitation process, if requested.

Respect. This healthcare model is established to provide respect to caregivers, patients and family members. Patients can uniquely participate, as we respect their daily activities, work or daily obligations.

Flexibility. Objective measurements and a daily eDiary question can be completed at the time and location of the patient's choosing, allowing the necessary flexibility to go to work or school. Moreover, by this flexible scheme, patients and caregivers are released from labour-intensive in-hospital consultation interviews or tests. The time required for telemetric device usage is limited to a few minutes per day, with the exception of the automated continuous data registration by the activity tracker in the daytime and by the sleep monitoring system at night. The toolbox is personalized for each user, as the intake interview can determine which of the available components (devices) should be used for individual follow-up.

5. Applicable IPR rules

The intellectual property is currently owned by Antwerp University Hospital (UZA) and BeWell innovations NV. The name Appi@Home is a registered trademark by UZA. In the near future, collaboration with KU Leuven (Department of Computer Science) is planned to increase patient adherence to telemonitoring using gamification techniques.

6. Information on the partners

The discrepancy between multidisciplinary knowledge and perioperative treatment, and the lack of long-term postsurgical follow-up for patients at risk of pain chronification, have been identified by Prof. Hans. To identify readily usable and flexible solutions, collaboration has been started with the involved in-hospital specialties (Multidisciplinary Pain Center & Anaesthesiology, in association with the Departments of Thoracic and Vascular Surgery, Physical Medicine and Rehabilitation and Paediatrics) and BeWell innovations, a company specializing in medical eHealth technology. Discussing the needs and solutions resulted in a novel and innovative approach for patients undergoing pectus surgery, as described above. The implementation of this care pathway will be further explored in other surgical domains.



Addendum: Contact information

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