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## Ear for Recovery: Protocol for a prospective study on parent-child communication and psychological recovery after paediatric injury

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**Ear for Recovery:  
Protocol for a prospective study on parent-child communication and psychological  
recovery after paediatric injury**

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## Abstract

### *Introduction*

One in six children who have been admitted to hospital with an injury develop persistent stress symptoms that put their development at risk. Parents play a crucial role in children's psychological recovery, however it is unknown how specific parenting behaviours can help or hinder. We aim to describe the nature and extent of parent-child communication after a child has been injured, and to examine how these interactions are related to children's psychological recovery.

### *Methods and analysis*

We are conducting a prospective observational study among children aged 3-16 years, who have been admitted to a tertiary children's hospital with a serious injury. Data collection involves a naturalistic observation of spontaneous, everyday parent-child communication at home, shortly after discharge, and an assessment of children's psychological recovery at 6 weeks and 3 months post-injury. Main analyses comprise descriptive statistics, cluster analysis and analyses of variance.

### *Ethics and dissemination*

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (33103) and Monash University Human Research Ethics Committee (CF13/2515 - 2013001322). We aim to disseminate the findings through international peer-reviewed journals, international conferences and social media.

### **Strengths and limitations of this study**

- Fine-grained observation of parent-child interactions in daily life after paediatric injury
- Attention to both positive and negative predictors and outcomes
- Novel, unobtrusive, ecological momentary assessment method
- Transcription and coding of audio data is time- and labour-intensive

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**INTRODUCTION**

Injuries sustained in childhood have physical and psychosocial consequences that can last for years or even throughout the lifespan.[1] Stress reactions, such as nightmares, avoidance of places that remind them of the event, feelings of detachment and concentration difficulties, are common in children in the aftermath of serious injury. Winston and colleagues [2] found that 88% of children admitted to hospital with an injury after a road traffic accident reported one or more clinically significant symptoms of acute stress. For most children these symptoms are transient, however about 15% develop persistent posttraumatic stress symptoms, which can impair functioning in cognitive, social, emotional and physical domains.[3, 4] Children and adolescents with Posttraumatic Stress Disorder (PTSD) have been found to experience deficits in memory, attention and executive functioning.[5] They show more emotion regulation difficulties, such as aggression [6] and experience difficulties maintaining relationships with friends.[7] Posttraumatic stress is also related to increased use of general health care.[8]

Childhood injury is a specific and easily identifiable event which both constitutes a strong risk factor, and places those at risk within a health system. This presents an opportunity to provide children and their families with information and support aimed at secondary prevention of post-traumatic stress and further consequences. Web-based psychoeducation and targeted brief early intervention for injured children and their parents have shown a modest effect [9] and additional research has been called for to refine preventive approaches. In particular, these should be focused on parent-child processes.[9,10]

Parents have an active function in the immediate aftermath of an injury, including seeking emergency care, supporting their child through painful medical procedures, modelling a coping response, providing ongoing support and organising follow-up treatment. Parents have been shown to play a crucial role in children's post-trauma outcomes,[11] although this evidence has predominantly focused on the role of parental distress.[3] More broadly, child anxiety and emotion regulation research has shown that parents can reinforce unfavourable coping strategies as well as active, prosocial coping in children.[12-14]. Finally, in-depth interviews showed that children attach great value to parental support after trauma.[15] While it has been established *that parents can play* a crucial role in children's psychological recovery from serious injury,[16] the next step is to examine what parents *actually do* that helps or hinders their child's recovery. Examining patterns of parent-child communication in daily life and associations between these and children's recovery will help in developing targeted and tailored interventions.[9]

The child medical traumatic stress domain has only recently moved towards a greater focus on parents, and studies in this vein have mostly utilised retrospective self-report methodologies. Studies of parents' behaviour after a child's potentially traumatic experience via retrospective questionnaires or interviews are challenged by vulnerability to biases related to self-report, such as social desirability, recall bias, impression management, lack of self-knowledge and mental health status.[17] In addition, many daily behaviours are so subtle and natural that people have difficulty identifying and reporting on them. Many of these challenges can be overcome using an observational approach that measures daily parent-child interactions in real life. In fact, the general developmental and anxiety literature includes many real-time observational studies of parents interacting with their children; however these are mostly families from the general population or clinical samples that are not necessarily

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2  
3 trauma-exposed, participating in brief non-naturalistic observations (i.e. families are given a  
4 particular task and are taped).[18] In short, the traumatic stress literature has an evidence base  
5 that is on-topic but requires more detail and ecological validity to inform clinical practice,  
6 while the general developmental and anxiety literature has an evidence base that is detailed  
7 and rich but not trauma-specific nor in most cases entirely naturalistic.

8  
9 A recently developed method, called the Electronically Activated Recorder (EAR),[19]  
10 provides an opportunity to gather detailed, naturalistic observational data on parent-child  
11 communication in the aftermath of injury, without placing a high burden on participants. The  
12 EAR is an ecological momentary assessment method which captures snippets of acoustic  
13 information from participants' daily life. Ecological momentary assessment refers to the  
14 repeated sampling of subjects' current behaviours and experiences in real time, in subjects'  
15 natural environments.[20] The EAR software operates on a small, unobtrusive device such as  
16 an iPod, and records snippets of ambient sound at pre-set random or regular intervals. It is  
17 one of the few ways to capture person-centred behavioural observational data in a natural  
18 environment. In particular, previous analyses showed that a) after a short habituation period,  
19 the EAR operates unobtrusively and minimally interferes with participants' normal activities;  
20 b) behavioural information can be reliably decoded from the sampled sounds; c) behavioural  
21 aggregates based on two days of monitoring show good temporal stability; and d) the periodic  
22 sampling pattern yields generalisable estimates of a person's daily behaviour (see [17]).  
23 When used in combination with questionnaires, the EAR has the advantage of minimising  
24 method variance.[17]

### 27 **Research aim and objectives**

28 This study aims to describe the nature and extent of parent-child communication after a child  
29 has been injured, and to examine how communication is related to children's psychological  
30 recovery, as well as other child, parent, and family wellbeing variables. The findings will  
31 inform the development of clinical guidance to parents on how to help their child recover  
32 psychologically after injury. In particular, our main research objectives are to:

- 33 1. Characterise parent-child communication in the aftermath of children's serious injury;
- 34 2. Examine relationships between these parent-child communication patterns and children's  
35 psychological recovery.

## 38 **METHODS AND ANALYSIS**

### 39 **Study design**

40 The project is a prospective observational study. Children aged 3 to 16 years who have  
41 sustained a serious injury and their parents are enrolled at the Royal Children's Hospital  
42 Melbourne, Australia. This hospital is a tertiary children's hospital with a statewide paediatric  
43 trauma centre. Data are collected at:

- 44 1. *Baseline:* In-hospital (T1a), we collect questionnaire data regarding demographics,  
45 injury characteristics, child acute stress and parent acute stress.  
46 Shortly after discharge (T1b), we collect EAR recordings of two days of  
47 children's daily life at home.
- 48 2. *Follow-up:* At 6 weeks (T2) and 3 months (T3) post-injury we conduct structured  
49 telephone interviews regarding child and family outcomes.

### 50 **Eligibility criteria**

Families of children who have been hospitalised for at least 24 hours due to an injury (cf. [21]) and are between 3 and 16 years of age are eligible, unless one or more of the following exclusion criteria apply: a) the injury has been, or is suspected to have been, caused by child maltreatment or self-harm; b) the family does not speak English in daily life (necessary for the coding of the EAR recordings); c) the child has sustained severe acquired brain injury (defined as a Glasgow Coma Scale [22] score < 9 at hospital presentation) and experiences continued impaired cognitive functioning at the time of approach (as decided by medical staff); d) the child is hospitalised for more than 4 weeks (we aim to measure parent-child communication within the first month post-injury); or e) the child's injury was secondary to an ongoing medical condition (e.g. a fracture associated with osteogenesis imperfecta).

### **Recruitment and procedures**

Potential participants are identified on a daily basis via the RCH Emergency Department and inpatient hospital databases. Initial contact with children and families is made via an in-hospital visit by a member of the research team and an RCH Trauma Service staff member. A brief description of the study and an information flyer are given to the child and family. If the family expresses interest in hearing more about the study, a member of the research team provides further information and documents the informed consent of participants and families. Subsequently, demographic and injury data are retrieved from the medical records. Children and parents fill out the baseline questionnaires at their earliest convenience and are provided with the EAR (an iPod pre-programmed with the EAR software). Children wear the EAR during the first weekend after discharge. At six weeks, and again at three months after the injury, psychological outcomes are assessed through telephone interviews with parents and with children if they are old enough.

### **Assessments**

Table 1 shows the assessments used in the study. The most important measures regard the observed parent-child communication and children's stress reactions.

Table 1. Ear for Recovery study assessments

Constructs	Standardised Measures	T1 In-hospital or at home	T2 Phone interview 6 weeks post-injury	T3 Phone interview 3 months post- injury
Demographics & injury characteristics	AIS	x		
Child stress reactions	CRIES-13, CPSS	x	x	x
Child social support	MSPSS	x		
Child wellbeing	KIDSCREEN-27, SDQ		x	x
Parent-child communication at home	EAR	x		
Parental stress reactions	ASDS	x		
Parental optimism	LOT-R	x		
Parental self-efficacy	SDRP	x		
Parental wellbeing	SF-36		x	x
Family functioning	FACES-IV	x		

*Note:* AIS = Abbreviated Injury Scale; CRIES-13 = Children's Revised Impact of Event Scale; CPSS = Child PTSD Symptom Scale; MSPSS = Multidimensional Scale of Perceived Social Support; SDQ = Strengths and Difficulties Questionnaire; EAR = Electronically Activated Recorder; ASDS = Acute Stress disorder Scale; LOT-R = Life Orientation Test – Revised; SDRP = Screener for the Development of Response Posttrauma; SF-36 = Short-Form Health Survey; FACES-IV = Family Adaptability and Cohesion Evaluation Scale IV.

## Primary measures

### *Child stress reactions*

Children's stress reactions are measured with the Children's Revised Impact of Event Scale (CRIES-13)[23] and the Child PTSD Symptom Scale (CPSS),[24] for children aged between 8 and 16 years. The CRIES-13 measures intrusion, avoidance, and arousal symptoms with 13 items on a 4-point scale. Reliability and validity of the CRIES-13 have been shown in several studies.[e.g.25] In one of our previous studies,  $\alpha$  was .85.[26]. The CPSS is a 24-item measure that can be used in structured interview format and yields a continuous severity score, an impairment score, and a probable PTSD status. The scale has shown excellent internal consistency, test-retest reliability, and convergent validity,[24] and has been used successfully in medical child traumatic stress research.[4] To include at least minimal data on younger children, parents of children of all age groups are asked to rate on a visual analogue scale how upset their child was directly after the event and how upset the child is at the time of assessment.

### *Parent-child communication*

Families are loaned an EAR (a pre-programmed iPod) to be used on the first feasible weekend after the child is discharged from the hospital. During two consecutive days, the injured child wears the EAR in a protective elastic belt on the outside of their clothes. Families are asked to keep a simple diary to identify the child's activities, who they are with, and any times the EAR is not worn by the child. The EAR records ambient sounds for 30 seconds every 5 minutes, from 7am to 10pm, totalling about 10% of the time. The sampling pattern yields about 160 sound files (80 min of recording) per person per day. This has been found sufficient to derive both reliable and valid data on people's unique communication patterns,[17,27] and by sampling only a fraction of the time, makes large observational studies feasible. The reliability, validity, and unobtrusiveness of the EAR have been previously reported.[17,27,28] Transcription and coding of the EAR data is described below.

## Secondary measures

### *Demographics and injury characteristics*

Demographics, including family structure, are collected from the parents. Children's injury type (mechanism and general description) and severity (ISS; Injury Severity Score based on the Abbreviated Injury Scale)[29] are retrieved from the trauma registry of the RCH. Families are also asked whether one or both parents were present at the event that caused the injury, whether the child or a parent has been confronted with a traumatic event before, and whether the child or a parent has used mental health care services in the past 3 years.

### *Child social support*

Children's perceived social support is measured with the Multidimensional Scale of Perceived Social Support (MSPSS).[30] The 12-item measure reflects perceived support from family members, a special person, and friends on a 7-point scale. Higher scores indicate more (perceived) social support. Reliability of the measure is high, as shown by a recent Australian study ( $\alpha = .90$ ).[31]

### *Child wellbeing*

The KIDSCREEN-27 [32] is used to assess the wellbeing of children aged 8-16 years. It is a 27-item instrument that covers five dimensions of quality of life on a 5-point scale: physical wellbeing, psychological wellbeing, autonomy and relationship with parents, peers and social



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3 support, and school environment. Validity and reliability are good [32, 33]. In addition,  
4 children are asked to indicate on a visual-analogue scale how happy they felt a week before  
5 the injury happened, how happy they feel currently, and how happy they expect to feel in one  
6 month's time. Further information regarding child well-being in all age groups is gathered via  
7 parents answering the Strengths and Difficulties Questionnaire (SDQ) [34] at T2 and T3. The  
8 SDQ is a brief behavioural screening questionnaire about 3-17 year olds that is used often  
9 internationally. The reliability and validity of the SDQ have been described extensively [34].  
10 We use the Australian age-adapted versions (for 3 year old; 4-10 year old; and 11-17 year old  
11 children).  
12

#### 13 *Parental stress reactions*

14 The Acute Stress Disorder Scale (ASDS)[35] is used to assess parental acute stress reactions.  
15 The ASDS is a self-report scale with 19 items that measure acute stress according to the  
16 DSM-IV diagnostic criteria.[36] Parents rate the extent to which they have experienced each  
17 symptom since the injury of their child on a 5-point scale. The scale is reliable ( $\alpha = .96$ ) and  
18 has shown high sensitivity and specificity when compared with a diagnostic interview for  
19 Acute Stress Disorder.[35]  
20

#### 21 *Parental optimism*

22 Parental optimism is measured with the revised Life Orientation Test (LOT-R).[37] The  
23 measure has four 'filler' items that are not included in the score. The six remaining items  
24 measure participants' expectations about their future and their general sense of optimism on a  
25 5-point scale. Reliability of the scale is acceptable ( $\alpha = .75$ ) and its validity is well-researched  
26 and confirmed.[38] In addition, parents indicate on a visual analogue scale how happy or  
27 unhappy they feel and how confident they feel that they will be able to cope with a stressful  
28 situation.  
29

#### 30 *Parental self-efficacy*

31 Parental self-efficacy is measured by a 15-item adaptation of the Screener for the  
32 Development of Response Posttrauma (SDRP).[39] The SDRP measures participants'  
33 confidence in their ability to cope with a potentially traumatic event, with higher scores  
34 reflecting higher confidence.  
35

#### 36 *Parental wellbeing*

37 The Short-Form Health Survey (SF-36)[40] is used to measure parental wellbeing. The SF-36  
38 includes a single item measure of change in health status, and a multi-item scale measuring  
39 each of the following eight health domains: physical functioning, role limitations due to  
40 physical health problems, bodily pain, general health, vitality, social functioning, role  
41 limitations due to emotional problems and mental health. Higher scores indicate higher levels  
42 of health, and results can be divided into two aggregate scores in the physical component  
43 summary (PCS) and the mental component summary (MCS). Validity and reliability (PCS  $\alpha$   
44 = 0.92; MCS  $\alpha$  = 0.91) of the measure has been demonstrated comprehensively.[41]  
45

#### 46 *Family functioning*

47 Family functioning is measured with the Family Adaptability and Cohesion Evaluation Scale  
48 IV (FACES-IV) [42] (parent report). The measure contains 84 items which assess high and  
49 low extremes of family cohesion and flexibility across six scales: balanced cohesion,  
50 balanced flexibility, enmeshed, disengaged, chaotic and rigid. Validity and reliability of the  
51 scales are good.[43]  
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## Data preparation and analysis

Handling of the data will be split into two broad stages: (1) EAR data preparation involving transcribing and coding as well as reliability checking and (2) statistical analysis involving EAR data and questionnaire data.

### Stage 1: EAR data preparation

EAR data preparation involves transcription and coding by trained research assistants receiving regular supervision. Each audio file will be prepared by at least two transcribers/coders, allowing for corrections and reliability analyses.

#### *Transcribing*

Each audio file will be transcribed verbatim according to the guidelines of the computerised linguistic analysis program called Linguistic Inquiry and Word Count (LIWC).[44] The transcriptions will subsequently be submitted to the LIWC software, which compares each word of a given text to a dictionary arranged into 74 categories (e.g. family words, sadness words) and reports total numbers of words and proportions of overall word use which fall into specific word categories.

#### *Coding*

Audio file coding will focus on parent-child interactions, children's activities and behaviours, and the topics and tone of conversations. A standardised behavioural coding scheme – a system that details acoustically-detectable aspects of participants' social environment and interactions adapted from previous EAR studies– will be used.[17] Each sound file will be coded for a) interaction (e.g. with how many people, who is talking); b) activity (e.g. watching TV, eating); c) mood/health of the child (e.g. laughing, crying, groaning from pain); d) topic of conversation (e.g. emotions/feelings, child rearing, injury related), and e) tone of conversation (e.g. 1 = very negative to 7 = very positive, with 4 being neutral; see Figure 1 for an example).

Figure 1. Standardised behavioural coding scheme (attached separately)

#### *Reliability analyses*

The audio files will be coded by two research assistants, after which intercoder reliability will be calculated using intraclass correlations. Previous EAR studies have reported good reliability after coder training. For example in a recent study by Robbins et al., intraclass correlations for all coding categories ranged from .76 to .92.[45]

### Stage 2: Statistical analysis

Our main questions regard a) the nature and extent of parent-child communication after paediatric injury and b) the relation between parent-child communication and children's psychological recovery.

#### *Nature and extent of parent-child communication*

After describing the sample (in terms of mean scores, standard deviations, and proportions), we will identify typologies of parent-child communication using two-step clustering. Two-step cluster analyses are used to reveal natural, homogeneous subgroups within a dataset that

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3 may not otherwise be apparent.[46] It is a person-centred approach that is particularly suited  
4 for new areas of research. Each family will be allocated to one cluster based on statistical  
5 similarity within clusters and dissimilarity between clusters. For example, clustering can take  
6 place based on the following four variables: 1) the amount of time that parents spend with  
7 their children in the aftermath of serious injury, 2) the proportion of interaction time in which  
8 the injury or its consequences is discussed, 3) the proportion of positive interactions, 4) the  
9 proportion of negative interactions. We will test stability of the generated clusters by  
10 repeating the procedure with the sample split in two.[46] When a stable set of clusters has  
11 been generated, these will be interpreted and labelled by the research team. For example, a  
12 cluster could consist of ‘withdrawn’ parents (who may show low interaction, low injury  
13 discussion, and low positive interactions).  
14

### 15 *Associations with children’s psychological recovery*

16  
17 In order to understand which clusters of parenting behaviour are related to higher and lower  
18 levels of child posttraumatic stress, we will conduct analyses of variance. Parenting  
19 behaviour (within clusters) will be the independent variable and child posttraumatic stress  
20 score (based on the CPSS) the dependent variable. When significant, we will conduct  
21 multiple comparisons between groups with a Tukey-test.  
22

### 23 *Secondary analyses*

24  
25 In addition to these main analyses (clustering and associations with child stress outcomes),  
26 the data will allow for the quantitative and qualitative exploration of associations among  
27 communication factors and child, parent and family wellbeing.  
28

### 29 **Sample size**

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31 With regard to describing the nature and extent of parent-child communication, means and  
32 proportions of behaviours can be described based on smaller sample sizes than inferential  
33 statistics. For clustering procedures, there is no generally accepted rule of thumb for  
34 minimum sample sizes. Formann advocates a sample size of at least  $2^m$ , where  $m$  equals the  
35 number of clustering variables, suggesting that large sample sizes are not required (e.g. 16  
36 families if clusters were based on four variables).[47] In order to relate communication  
37 characteristics to subsequent outcomes, the sample size requirements would increase with the  
38 number of variables involved. Previously published EAR studies have conducted data  
39 analyses with samples sizes of approximately 50 families (e.g.[45,48]). As Finkel, Eastwick  
40 and Reis indicate, in this type of research, it is important to balance Type 1 and Type 2  
41 errors.[49] The larger the sample size, the more fine-grained the analyses can be. We expect a  
42 sample size of approximately 70 families and intend to make the data available for future  
43 studies in order to ensure sufficient future sample sizes.  
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## 46 **ETHICS AND DISSEMINATION**

47  
48 This study has been approved by the Human Research Ethics Committee of the Royal  
49 Children’s Hospital Melbourne (study number 33103) and Monash University Human  
50 Research Ethics Committee (file number CF13/2515 - 2013001322). Signed informed  
51 consent is obtained from all participating families. We aim to disseminate the results of the  
52 study through international peer-reviewed journals, international conferences and social  
53 media. In addition, depending on approval from the institutions involved, we aim to make de-  
54 identified data from the study available for secondary analyses by external researchers.  
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### Particular ethical considerations associated with EAR research

Mehl and colleagues [17] have previously highlighted a number of considerations specific to conducting EAR research such as issues of confidentiality when recording ambient sounds, and recording bystanders, discussed below.

#### *Recording bystanders*

The EAR records anything occurring in the acoustic environment of the child wearing it – anyone talking to, or talking near the child, including in public spaces, may be recorded. This means that some people recorded will not have provided written consent. As the recording takes place in the participant's natural environment shortly after hospital discharge, the majority of recordings take place in the home and involve immediate family members who are aware of the study. In order to ensure that bystanders are aware of the study, participants are asked to make the EAR visible by wearing it on the outside of their clothes with a 'RECORDING' label sewn onto the elastic belt. Participants and their parents are also advised to tell anyone coming into contact with the child over the recording weekend that the child is wearing the EAR. These steps, together, ensure that bystanders are aware of the potential of being recorded and therefore, in essence, passively consent to it. Along with the de-identification procedures described below, this makes it unlikely that the privacy rights of non-consented people who are recorded are violated.

#### *Privacy and de-identification*

The EAR is programmed to record only a small fraction of a person's day. Sampling occurs for 30 seconds every 5 minutes, allowing the EAR to "reliably extract basic behavioural information, yet [recordings] are short enough to capture only little contextualized personal information".[17] While the brevity of the sound files protects participants' privacy to a certain extent, identifying information is still often contained within them. Research team members involved in data preparation are trained to recognise and remove such information, including names, places, and contact information. All identifying information is highlighted by researchers during the transcribing and coding process, and as each participant's recordings are transcribed and coded multiple times by separate researchers, there are multiple opportunities for identifying information to be detected. Any identifying information within audio recordings is then deleted by silencing the relevant sections of the sound file. During transcription, any identifying words are replaced by functional codes. For example, "Anna, can you turn the TV off?" becomes "[S1ster], can you turn the TV off?" Any written identifying information (for example names written within the participant diaries) is blacked out after use.

## DISCUSSION

While serious injury puts children's healthy development at risk, currently available early interventions have only been modestly successful in preventing the development of persistent posttraumatic stress symptoms.[4,9] With parents playing a central role in children's recovery,[3,16] targeting parental support behaviour appears to be an important avenue for improving early interventions.

The Ear for Recovery study differs from previous research in its use of an unobtrusive naturalistic observation device to collect objective data in family situations that normally would go unstudied or would rely on self-report. The outcomes of the current project will allow us to a) better understand families' experiences after child injuries and therefore improve professional interactions with families; b) indicate which parental behaviour may be

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3 helpful vs. unhelpful, leading to specific recommendations for future early interventions  
4 (learning from the successful behaviour patterns while targeting the unsuccessful ones); c)  
5 identify parents who may be in need of a tailored early intervention to help them support their  
6 child in the aftermath of a serious injury; and d) further develop the EAR methodology as a  
7 diagnostic tool in child (mental) health research.  
8

9 An important challenge of this study regards the time-consuming and labour intensive  
10 process involved in handling the large volumes of audio data. It is possible that as technology  
11 develops there will be the opportunity to make use of advanced speech recognition software,  
12 however such software is not yet sophisticated enough to pick up on many of the subtleties  
13 that make up social interactions. A limitation of the current study is that we do not include an  
14 observation within the first few hours or day after the injury. It is possible that relevant  
15 parent-child interaction patterns take place in those first moments and become less frequent  
16 or prominent in the following days and weeks. In addition, an observation at the time points  
17 of the follow-ups were not feasible within the current study but would be of value for future  
18 research.  
19

20 With the EAR methodology we will be able to provide a detailed characterisation of  
21 parent-child communication after serious injury. The current study aims to pave the way for  
22 better interventions to facilitate children's psychological recovery after serious injury.  
23 Implications may include exploring opportunities for use of the EAR methodology as a  
24 diagnostic measure in its own right and to inform other areas of child physical and mental  
25 health.  
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### Contributors

EA is the principal investigator of this study. EA, AB, FB, RC, RMC, VA and MM designed the study. EA, PB and AB drafted the manuscript. FB, RC, RMC, VA and MM provided feedback on the manuscript. All authors approved the manuscript.

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### Competing interests

None

### Ethics approval

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (study number 33103) and Monash University Human Research Ethics Committee (file number CF13/2515 - 2013001322).

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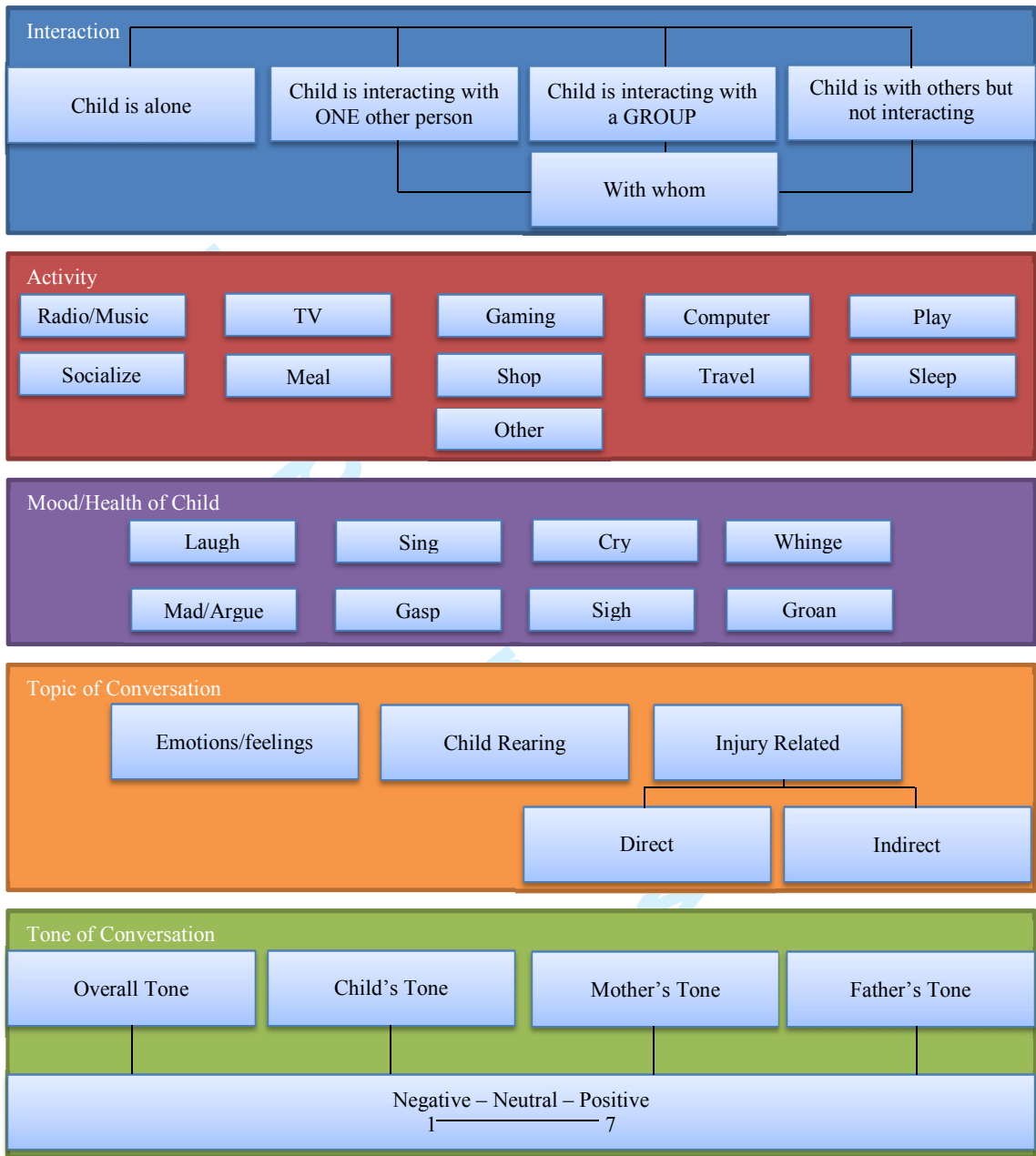
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Figure 1. Standardised behavioural coding scheme



# BMJ Open

## Ear for Recovery: Protocol for a prospective study on parent-child communication and psychological recovery after paediatric injury

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3 **Ear for Recovery:**  
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## Abstract

### *Introduction*

One in six children who have been admitted to hospital with an injury develop persistent stress symptoms that put their development at risk. Parents play a crucial role in children's psychological recovery, however it is unknown how specific parenting behaviours can help or hinder. We aim to describe the nature and quantity of parent-child communication after a child has been injured, and to examine how these interactions are related to children's psychological recovery.

### *Methods and analysis*

We are conducting a prospective observational study among children aged 3-16 years, who have been admitted to a tertiary children's hospital with a serious injury. Data collection involves a naturalistic observation of spontaneous, everyday parent-child communication at home, shortly after discharge, and an assessment of children's psychological recovery at 6 weeks and 3 months post-injury. Main analyses comprise descriptive statistics, cluster analysis and analyses of variance.

### *Ethics and dissemination*

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (33103) and Monash University Human Research Ethics Committee (CF13/2515 - 2013001322). We aim to disseminate the findings through international peer-reviewed journals, international conferences and social media. Participants will be sent a summary of the overall study findings.

### **Strengths and limitations of this study**

- Fine-grained observation of parent-child interactions in daily life after paediatric injury
- Attention to both positive and negative predictors and outcomes
- Novel, unobtrusive, ecological momentary assessment method
- Transcription and coding of audio data is time- and labour-intensive

**Ear for Recovery:  
Protocol for a prospective observational study on parent-child communication and  
psychological recovery after paediatric injury**

**INTRODUCTION**

Injuries sustained in childhood have physical and psychosocial consequences that can last for years or even throughout the lifespan.[1] Stress reactions, such as nightmares, avoidance of places that remind them of the event, feelings of detachment and concentration difficulties, are common in children in the aftermath of serious injury. Winston and colleagues [2] found that 88% of children admitted to hospital with an injury after a road traffic accident reported one or more clinically significant symptoms of acute stress. For most children these symptoms are transient, however about 15% develop persistent posttraumatic stress symptoms, which can impair functioning in cognitive, social, emotional and physical domains.[3, 4] Children and adolescents with Posttraumatic Stress Disorder (PTSD) have been found to experience deficits in memory, attention and executive functioning.[5] They show more emotion regulation difficulties, such as aggression, than children without PTSD[6] and experience difficulties maintaining relationships with friends.[7] Posttraumatic stress is also related to increased use of general health care.[8]

Childhood injury is a specific and easily identifiable event which both constitutes a risk factor for physical and psychosocial difficulties, and places those at risk within a health system. This presents an opportunity to provide children and their families with information and support aimed at secondary prevention of post-traumatic stress and further consequences. Web-based psychoeducation and targeted brief early intervention for injured children and their parents have shown a modest effect [9] and additional research has been called for to refine preventive approaches. In particular, these should be focused on parent-child processes.[9,10]

Parents have an active function in the immediate aftermath of an injury, including seeking emergency care, supporting their child through painful medical procedures, modelling a coping response, providing ongoing support and organising follow-up treatment. Parents have been shown to play a crucial role in children's post-trauma outcomes,[11] although this evidence has predominantly focused on the role of parental distress.[3] More broadly, child anxiety and emotion regulation research has shown that parents can reinforce unfavourable coping strategies as well as active, prosocial coping in children.[12-14]. Finally, in-depth interviews showed that children attach great value to parental support after trauma.[15] While it has been established *that parents can play* a crucial role in children's psychological recovery from serious injury,[16] the next step is to examine what parents *actually do* that helps or hinders their child's recovery. Examining patterns of parent-child communication in daily life and associations between these and children's recovery will help in developing targeted and tailored interventions.[9]

The child medical traumatic stress domain has only recently moved towards a greater focus on parents, and studies in this vein have mostly utilised retrospective self-report methodologies. Studies of parents' behaviour after a child's potentially traumatic experience via retrospective questionnaires or interviews are challenged by vulnerability to biases related to self-report, such as social desirability, recall bias, impression management, lack of self-knowledge and mental health status.[17] In addition, many daily behaviours are so subtle and natural that people have difficulty identifying and reporting on them. Many of these challenges can be overcome using an observational approach that measures daily parent-child interactions in real life. In fact, the general developmental and anxiety literature includes many real-time observational studies of parents interacting with their children; however these

are mostly families from the general population or clinical samples that are not necessarily trauma-exposed, participating in brief non-naturalistic observations (i.e. families are given a particular task and are taped).[18] In short, the traumatic stress literature has an evidence base that is on-topic but requires more detail and ecological validity to inform clinical practice, while the general developmental and anxiety literature has an evidence base that is detailed and rich but not trauma-specific nor in most cases entirely naturalistic.

A recently developed method, called the Electronically Activated Recorder (EAR),[19] provides an opportunity to gather detailed, naturalistic observational data on parent-child communication in the aftermath of injury, without placing a high burden on participants. The EAR is an ecological momentary assessment method which captures snippets of acoustic information from participants' daily life. Ecological momentary assessment refers to the repeated sampling of subjects' current behaviours and experiences in real time, in subjects' natural environments.[20] The EAR software operates on a small, unobtrusive device such as an iPod, and records snippets of ambient sound at pre-set random or regular intervals. It is one of the few ways to capture person-centred behavioural observational data in a natural environment. In particular, previous analyses showed that a) after a short habituation period, the EAR operates unobtrusively and minimally interferes with participants' normal activities; b) behavioural information can be reliably decoded from the sampled sounds; c) behavioural aggregates based on two days of monitoring show good temporal stability; and d) the periodic sampling pattern yields generalisable estimates of a person's daily behaviour (see [17]). When used in combination with questionnaires, the EAR has the advantage of minimising method variance.[17]

### Research aim and objectives

This study aims to describe the nature and quantity of parent-child communication after a child has been injured, and to examine how communication is related to children's psychological recovery, as well as other child, parent and family wellbeing variables. The findings will inform the development of clinical guidance to parents on how to help their child recover psychologically after injury. In particular, our main research objectives are to:

1. Characterise parent-child communication in the aftermath of children's serious injury;
2. Examine relationships between these parent-child communication patterns and children's psychological recovery.

## METHODS AND ANALYSIS

### Study design

The project is a prospective observational study. Children aged 3 to 16 years who have sustained a serious injury and their parents are enrolled at the Royal Children's Hospital Melbourne, Australia. This hospital is a tertiary children's hospital with a statewide paediatric trauma centre. Data are collected at:

1. *Baseline:* In-hospital (T1a), we collect questionnaire data regarding demographics, injury characteristics, child acute stress and parent acute stress. Shortly after discharge (T1b), we collect EAR recordings of two days of children's daily life at home.
2. *Follow-up:* At 6 weeks (T2) and 3 months (T3) post-injury we conduct structured telephone interviews regarding child and family outcomes.

### Eligibility criteria



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3 Families of children who have been hospitalised for at least 24 hours due to an injury (cf. [21])  
4 and are between 3 and 16 years of age are eligible, unless one or more of the following  
5 exclusion criteria apply: a) the injury has been, or is suspected to have been, caused by child  
6 maltreatment or self-harm; b) the family does not speak English in daily life (necessary for  
7 the coding of the EAR recordings); c) the child has sustained severe acquired brain injury  
8 (defined as a Glasgow Coma Scale [22] score < 9 at hospital presentation) and experiences  
9 continued impaired cognitive functioning at the time of approach (as decided by medical  
10 staff); d) the child is hospitalised for more than 4 weeks (we aim to measure parent-child  
11 communication within the first month post-injury); or e) the child's injury was secondary to  
12 an ongoing medical condition (e.g. a fracture associated with osteogenesis imperfecta).  
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### 15 **Recruitment and procedures**

16 Potential participants are identified on a daily basis via the RCH Emergency Department and  
17 inpatient hospital databases. Initial contact with children and families is made via an in-  
18 hospital visit by a member of the research team and an RCH Trauma Service staff member. A  
19 brief description of the study and an information flyer are given to the child and family. If the  
20 family expresses interest in hearing more about the study, a member of the research team  
21 provides further information and documents the informed consent of participants and families.  
22 Subsequently, demographic and injury data are retrieved from the medical records. Children  
23 and parents fill out the baseline questionnaires at their earliest convenience and are provided  
24 with the EAR (an iPod Touch pre-programmed with the EAR software). Children wear the  
25 EAR during the first weekend after discharge. At six weeks, and again at three months after  
26 the injury, psychological outcomes are assessed through telephone interviews with parents  
27 and with children if they are old enough.  
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### 31 **Assessments**

32 Table 1 shows the assessments used in the study. The most important measures regard the  
33 observed parent-child communication and children's stress reactions.  
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Table 1. Ear for Recovery study assessments

Constructs	Standardised Measures	T1 In-hospital or at home	T2 Phone interview 6 weeks post-injury	T3 Phone interview 3 months post- injury
Demographics & injury characteristics	AIS	x		
Child stress reactions	CRIES-13, CPSS	x	x	x
Child social support	MSPSS	x		
Child wellbeing	KIDSCREEN-27, SDQ		x	x
Parent-child communication at home	EAR	x		
Parental stress reactions	ASDS	x		
Parental optimism	LOT-R	x		
Parental self-efficacy	SDRP	x		
Parental wellbeing	SF-36		x	x
Family functioning	FACES-IV	x		

*Note:* AIS = Abbreviated Injury Scale; CRIES-13 = Children's Revised Impact of Event Scale; CPSS = Child PTSD Symptom Scale; MSPSS = Multidimensional Scale of Perceived Social Support; SDQ = Strengths and Difficulties Questionnaire; EAR = Electronically Activated Recorder; ASDS = Acute Stress disorder Scale; LOT-R = Life Orientation Test – Revised; SDRP = Screener for the Development of Response Posttrauma; SF-36 = Short-Form Health Survey; FACES-IV = Family Adaptability and Cohesion Evaluation Scale IV.

## Primary measures

### *Child stress reactions*

Children's stress reactions are measured with the Children's Revised Impact of Event Scale (CRIES-13)[23] and the Child PTSD Symptom Scale (CPSS),[24] for children aged between 8 and 16 years. The CRIES-13 measures intrusion, avoidance and arousal symptoms with 13 items on a 4-point scale. Reliability and validity of the CRIES-13 have been shown in several studies.[e.g.25] In one of our previous studies,  $\alpha$  was .85.[26]. The CPSS is a 24-item measure that can be used in structured interview format and yields a continuous severity score, an impairment score, and a probable PTSD status. The scale has shown excellent internal consistency, test-retest reliability and convergent validity,[24] and has been used successfully in medical child traumatic stress research.[4] To include at least minimal data on younger children, parents of children of all age groups are asked to rate on a visual analogue scale how upset their child was directly after the event and how upset the child is at the time of assessment.

### *Parent-child communication*

Families are loaned an EAR (a pre-programmed iPod Touch) to be used on the first feasible weekend after the child is discharged from the hospital. During two consecutive days, the injured child wears the EAR in a protective elastic belt on the outside of their clothes. Families are asked to keep a simple diary to identify the child's activities, who they are with, and any times the EAR is not worn by the child. The EAR records ambient sounds for 30 seconds every 5 minutes, from 7am to 10pm, totalling about 10% of the time. The sampling pattern yields about 160 sound files (80 min of recording) per person per day. This has been found sufficient to derive both reliable and valid data on people's unique communication patterns,[17,27] and by sampling only a fraction of the time, makes large observational studies feasible. The reliability, validity and unobtrusiveness of the EAR have been previously reported.[17,27,28] Transcription and coding of the EAR data is described below.

## Secondary measures

### *Demographics and injury characteristics*

Demographics, including family structure, are collected from the parents. Children's injury type (mechanism and general description) and severity (ISS; Injury Severity Score based on the Abbreviated Injury Scale)[29] are retrieved from the trauma registry of the RCH. Families are also asked whether one or both parents were present at the event that caused the injury, whether the child or a parent has been confronted with a traumatic event before, and whether the child or a parent has used mental health care services in the past 3 years.

### *Child social support*

Children's perceived social support is measured with the Multidimensional Scale of Perceived Social Support (MSPSS).[30] The 12-item measure reflects perceived support from family members, a special person and friends on a 7-point scale. Higher scores indicate more (perceived) social support. Reliability of the measure is high, as shown by a recent Australian study ( $\alpha = .90$ ).[31]

### *Child wellbeing*

The KIDSCREEN-27 [32] is used to assess the wellbeing of children aged 8-16 years. It is a 27-item instrument that covers five dimensions of quality of life on a 5-point scale: physical wellbeing, psychological wellbeing, autonomy and relationship with parents, peers and social

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3 support, and school environment. Validity and reliability are good [32, 33]. In addition,  
4 children are asked to indicate on a visual-analogue scale how happy they felt a week before  
5 the injury happened, how happy they feel currently and how happy they expect to feel in one  
6 month's time. Further information regarding child well-being in all age groups is gathered via  
7 parents answering the Strengths and Difficulties Questionnaire (SDQ) [34] at T2 and T3. The  
8 SDQ is a brief behavioural screening questionnaire about 3-17 year olds that is used often  
9 internationally. The reliability and validity of the SDQ have been described extensively [34].  
10 We use the Australian age-adapted versions (for 3 year old; 4-10 year old; and 11-17 year old  
11 children).  
12

### 13 *Parental stress reactions*

14 The Acute Stress Disorder Scale (ASDS)[35] is used to assess parental acute stress reactions.  
15 The ASDS is a self-report scale with 19 items that measure acute stress according to the  
16 DSM-IV diagnostic criteria.[36] Parents rate the extent to which they have experienced each  
17 symptom since the injury of their child on a 5-point scale. The scale is reliable ( $\alpha = .96$ ) and  
18 has shown high sensitivity and specificity when compared with a diagnostic interview for  
19 Acute Stress Disorder.[35]  
20

### 21 *Parental optimism*

22 Parental optimism is measured with the revised Life Orientation Test (LOT-R).[37] The  
23 measure has four 'filler' items that are not included in the score. The six remaining items  
24 measure participants' expectations about their future and their general sense of optimism on a  
25 5-point scale. Reliability of the scale is acceptable ( $\alpha = .75$ ) and its validity is well-researched  
26 and confirmed.[38] In addition, parents indicate on a visual analogue scale how happy or  
27 unhappy they feel and how confident they feel that they will be able to cope with a stressful  
28 situation.  
29

### 30 *Parental self-efficacy*

31 Parental self-efficacy is measured by the 15 efficacy-focused items of the Screener for the  
32 Development of Response Posttrauma (SDRP).[39] The scale measures participants'  
33 confidence in their ability to cope with a potentially traumatic event, with higher scores  
34 reflecting higher confidence (when the items referred to 'ill/injured' children we only  
35 retained the word 'injured').  
36

### 37 *Parental wellbeing*

38 The Short-Form Health Survey (SF-36)[40] is used to measure parental wellbeing. The SF-36  
39 includes a single item measure of change in health status and a multi-item scale measuring  
40 each of the following eight health domains: physical functioning, role limitations due to  
41 physical health problems, bodily pain, general health, vitality, social functioning, role  
42 limitations due to emotional problems and mental health. Higher scores indicate higher levels  
43 of health and results can be divided into two aggregate scores: the physical component  
44 summary (PCS) and the mental component summary (MCS). Validity and reliability (PCS  $\alpha$   
45 = 0.92; MCS  $\alpha$  = 0.91) of the measure have been demonstrated comprehensively.[41]  
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### 47 *Family functioning*

48 Family functioning is measured with the Family Adaptability and Cohesion Evaluation Scale  
49 IV (FACES-IV) [42] (parent report). The measure contains 84 items which assess high and  
50 low extremes of family cohesion and flexibility across six scales: balanced cohesion,  
51 balanced flexibility, enmeshed, disengaged, chaotic and rigid. Validity and reliability of the  
52 scales are good.[43]  
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## Data preparation and analysis

Handling of the data will be split into two broad stages: (1) EAR data preparation involving transcribing and coding as well as reliability checking and (2) statistical analysis involving EAR data and questionnaire data.

### Stage 1: EAR data preparation

EAR data preparation involves transcription and coding by trained research assistants receiving regular supervision. Each audio file (i.e. each 30 second segment) will be prepared by at least two transcribers/coders, allowing for corrections and reliability analyses. We expect to handle over 15,000 separate audio files.

#### *Transcribing*

Each audio file will be transcribed verbatim according to the guidelines of the computerised linguistic analysis program called Linguistic Inquiry and Word Count (LIWC).[44] The transcriptions will subsequently be aggregated and submitted to the LIWC software, which compares each word of a given text to a dictionary arranged into 74 categories (e.g. family words, sadness words) and reports total numbers of words and proportions of overall word use falling into the specific word categories.

#### *Coding*

Audio file coding will focus on parent-child interactions, children's activities and behaviours, and the topics and tone of conversations. The coding is manualised: a standardised behavioural coding scheme – a system that details acoustically-detectable aspects of participants' social environment and interactions adapted from previous EAR studies– will be used.[17] Each sound file will be coded for a) interaction (e.g. with how many people, who is talking); b) activity (e.g. watching TV, eating); c) mood/health of the child (e.g. laughing, crying, groaning from pain); d) topic of conversation (e.g. emotions/feelings, child rearing, injury related) and e) tone of conversation (e.g. 1 = very negative to 7 = very positive, with 4 being neutral; see Figure 1). As an example, with regard to interaction we will indicate for each audio file whether the child is alone or not, and in case of the latter, whether the child is a) interacting with one other person, b) interacting with a group (i.e. more than one person) or c) nearby other people (e.g. adults are talking among themselves a few meters away) but not interacting. If the child is interacting with one or more people, we will record the gender of the conversation partner(s).

Figure 1. Standardised behavioural coding scheme

#### *Reliability analyses*

The audio files will be coded by two research assistants, after which intercoder reliability will be calculated using intraclass correlations. Previous EAR studies have reported good reliability after coder training. For example in a recent study by Robbins et al., intraclass correlations for all coding categories ranged from .76 to .92.[45]

### Stage 2: Statistical analysis

Our main questions regard a) the nature and quantity of parent-child communication after paediatric injury and b) the relation between parent-child communication and children's psychological recovery.

#### *Nature and quantity of parent-child communication*

First, we will describe the sample in terms of mean scores, standard deviations and proportions. For example, we will examine the proportion of time that the children are interacting with others, and to what extent this figure varies across families. Second, we will identify typologies of parent-child communication using two-step clustering. Cluster analysis organises data into groups, or clusters. In particular, two-step cluster analyses are used to reveal natural, homogeneous subgroups within a dataset that may not otherwise be apparent.[46] It is a person-centred approach that is particularly suited for new areas of research. Each family will be allocated to one cluster based on statistical similarity within clusters and dissimilarity between clusters. For example, clustering can take place based on the following four variables: 1) the amount of time that parents spend with their children in the aftermath of serious injury, 2) the proportion of interaction time in which the injury or its consequences is discussed, 3) the proportion of positive interactions, 4) the proportion of negative interactions. We will test stability of the generated clusters by repeating the procedure with the sample split in two.[46] When a stable set of clusters has been generated, these will be interpreted and labelled by the research team. For example, a cluster could consist of 'withdrawn' parents (who may show low interaction, low injury discussion and low positive interactions).

#### *Associations with children's psychological recovery*

In order to understand which clusters of parenting behaviour are related to higher and lower levels of child posttraumatic stress, we will conduct analyses of variance. Parenting behaviour will be the independent variable (with the groups being compared as identified through the cluster analysis) and child posttraumatic stress score as the dependent variable (we will use the total symptom score of the CPSS). When significant, we will conduct multiple comparisons between groups with a Tukey-test.

#### *Secondary analyses*

In addition to these main analyses (clustering and associations with child stress outcomes), the data will allow for the quantitative and qualitative exploration of associations among communication factors and child, parent and family wellbeing.

#### **Sample size**

With regard to describing the nature and quantity of parent-child communication, means and proportions of behaviours can be described based on smaller sample sizes than inferential statistics. For clustering procedures, there is no generally accepted rule of thumb for minimum sample sizes. Formann advocates a sample size of at least  $2^m$ , where  $m$  equals the number of clustering variables, suggesting that large sample sizes are not required (e.g. 16 families if clusters were based on four variables).[47] In order to relate communication characteristics to subsequent outcomes, the sample size requirements would increase with the number of variables involved. Previously published EAR studies have conducted data analyses with samples sizes of approximately 50 families (e.g.[45,48]). As Finkel, Eastwick and Reis indicate, in this type of research, it is important to balance Type 1 and Type 2 errors.[49] The larger the sample size, the more fine-grained the analyses can be. We expect a sample size of approximately 70 families and intend to make the data available for future studies in order to ensure sufficient future sample sizes.

## ETHICS AND DISSEMINATION

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (study number 33103) and Monash University Human Research Ethics Committee (file number CF13/2515 - 2013001322). Signed informed consent is obtained from all participating families. We aim to disseminate the results of the study through international peer-reviewed journals, international conferences and social media. Participants will be sent a thank you letter with a summary of the overall study findings. In addition, depending on approval from the institutions involved, we aim to make de-identified data from the study available for secondary analyses by external researchers.

### **Particular ethical considerations associated with EAR research**

Mehl and colleagues [17] have previously highlighted a number of considerations specific to conducting EAR research such as issues of confidentiality when recording ambient sounds, and recording bystanders, discussed below.

#### *Recording bystanders*

The EAR records anything occurring in the acoustic environment of the child wearing it – anyone talking to, or talking near the child, including in public spaces, may be recorded. This means that some people recorded will not have provided written consent. As the recording takes place in the participant's natural environment shortly after hospital discharge, the majority of recordings take place in the home and involve immediate family members who are aware of the study. In order to ensure that bystanders are aware of the study, participants are asked to make the EAR visible by wearing it on the outside of their clothes with a 'RECORDING' label sewn onto the elastic belt. Participants and their parents are also advised to tell anyone coming into contact with the child over the recording weekend that the child is wearing the EAR. These steps, together, ensure that bystanders are aware of the potential of being recorded and therefore, in essence, passively consent to it. Along with the de-identification procedures described below, this makes it unlikely that the privacy rights of non-consented people who are recorded are violated.

#### *Privacy and de-identification*

The EAR is programmed to record only a small fraction of a person's day. Sampling occurs for 30 seconds every 5 minutes, allowing the EAR to "reliably extract basic behavioural information, yet [recordings] are short enough to capture only little contextualized personal information". [17] While the brevity of the sound files protects participants' privacy to a certain extent, identifying information is still often contained within them. Research team members involved in data preparation are trained to recognise and remove such information, including names, places and contact information. All identifying information is highlighted by researchers during the transcribing and coding process, and as each participant's recordings are transcribed and coded multiple times by separate researchers, there are multiple opportunities for identifying information to be detected. Any identifying information within audio recordings is then deleted by silencing the relevant sections of the sound file. During transcription, any identifying words are replaced by functional codes. For example, "Anna, can you turn the TV off?" becomes "[S1ster], can you turn the TV off?" Any written identifying information (for example names written within the participant diaries) is blacked out after use.

## DISCUSSION

While serious injury puts children's healthy development at risk, currently available early interventions have only been modestly successful in preventing the development of persistent posttraumatic stress symptoms.[4,9] With parents playing a central role in children's recovery,[3,16] targeting parental support behaviour appears to be an important avenue for improving early interventions.

The Ear for Recovery study differs from previous research in its use of an unobtrusive naturalistic observation device to collect objective data in family situations that normally would go unstudied or would rely on self-report. The outcomes of the current project will allow us to a) better understand families' experiences after child injuries and therefore improve professional interactions with families; b) indicate which parental behaviour may be helpful vs. unhelpful, leading to specific recommendations for future early interventions (learning from the successful behaviour patterns while targeting the unsuccessful ones); c) identify parents who may be in need of a tailored early intervention to help them support their child in the aftermath of a serious injury; and d) further develop the EAR methodology as a diagnostic tool in child (mental) health research.

An important challenge of this study regards the time-consuming and labour intensive process involved in handling the large volumes of audio data. It is possible that as technology develops there will be the opportunity to make use of advanced speech recognition software, however such software is not yet sophisticated enough to pick up on many of the subtleties that make up social interactions. A limitation of the current study is that we do not include an observation within the first few hours or day after the injury. It is possible that relevant parent-child interaction patterns take place in those first moments and become less frequent or prominent in the following days and weeks. In addition, an observation at the time points of the follow-ups were not feasible within the current study but would be of value for future research.

With the EAR methodology we will be able to provide a detailed characterisation of parent-child communication after serious injury. The current study aims to pave the way for better interventions to facilitate children's psychological recovery after serious injury. Implications may include exploring opportunities for use of the EAR methodology as a diagnostic measure in its own right and to inform other areas of child physical and mental health.



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### Contributors

EA is the principal investigator of this study. EA, AB, FB, RC, RMC, VA and MM designed the study. EA, PB and AB drafted the manuscript. FB, RC, RMC, VA and MM provided feedback on the manuscript. All authors approved the manuscript.

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### Competing interests

None

### Ethics approval

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (study number 33103) and Monash University Human Research Ethics Committee (file number CF13/2515 - 2013001322).

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**Ear for Recovery:  
Protocol for a prospective study on parent-child communication and psychological  
recovery after paediatric injury**

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## Abstract

### *Introduction*

One in six children who have been admitted to hospital with an injury develop persistent stress symptoms that put their development at risk. Parents play a crucial role in children's psychological recovery, however it is unknown how specific parenting behaviours can help or hinder. We aim to describe the nature and quantity of parent-child communication after a child has been injured, and to examine how these interactions are related to children's psychological recovery.

### *Methods and analysis*

We are conducting a prospective observational study among children aged 3-16 years, who have been admitted to a tertiary children's hospital with a serious injury. Data collection involves a naturalistic observation of spontaneous, everyday parent-child communication at home, shortly after discharge, and an assessment of children's psychological recovery at 6 weeks and 3 months post-injury. Main analyses comprise descriptive statistics, cluster analysis and analyses of variance.

### *Ethics and dissemination*

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (33103) and Monash University Human Research Ethics Committee (CF13/2515 - 2013001322). We aim to disseminate the findings through international peer-reviewed journals, international conferences and social media. Participants will be sent a summary of the overall study findings.

### **Strengths and limitations of this study**

- Fine-grained observation of parent-child interactions in daily life after paediatric injury
- Attention to both positive and negative predictors and outcomes
- Novel, unobtrusive, ecological momentary assessment method
- Transcription and coding of audio data is time- and labour-intensive

**Ear for Recovery:  
Protocol for a prospective observational study on parent-child communication and  
psychological recovery after paediatric injury**

## INTRODUCTION

Injuries sustained in childhood have physical and psychosocial consequences that can last for years or even throughout the lifespan.[1] Stress reactions, such as nightmares, avoidance of places that remind them of the event, feelings of detachment and concentration difficulties, are common in children in the aftermath of serious injury. Winston and colleagues [2] found that 88% of children admitted to hospital with an injury after a road traffic accident reported one or more clinically significant symptoms of acute stress. For most children these symptoms are transient, however about 15% develop persistent posttraumatic stress symptoms, which can impair functioning in cognitive, social, emotional and physical domains.[3, 4] Children and adolescents with Posttraumatic Stress Disorder (PTSD) have been found to experience deficits in memory, attention and executive functioning.[5] They show more emotion regulation difficulties, such as aggression, **than children without PTSD**[6] and experience difficulties maintaining relationships with friends.[7] Posttraumatic stress is also related to increased use of general health care.[8]

Childhood injury is a specific and easily identifiable event which both constitutes a risk factor **for physical and psychosocial difficulties**, and places those at risk within a health system. This presents an opportunity to provide children and their families with information and support aimed at secondary prevention of post-traumatic stress and further consequences. Web-based psychoeducation and targeted brief early intervention for injured children and their parents have shown a modest effect [9] and additional research has been called for to refine preventive approaches. In particular, these should be focused on parent-child processes.[9,10]

Parents have an active function in the immediate aftermath of an injury, including seeking emergency care, supporting their child through painful medical procedures, modelling a coping response, providing ongoing support and organising follow-up treatment. Parents have been shown to play a crucial role in children's post-trauma outcomes,[11] although this evidence has predominantly focused on the role of parental distress.[3] More broadly, child anxiety and emotion regulation research has shown that parents can reinforce unfavourable coping strategies as well as active, prosocial coping in children.[12-14]. Finally, in-depth interviews showed that children attach great value to parental support after trauma.[15] While it has been established *that parents can play* a crucial role in children's psychological recovery from serious injury,[16] the next step is to examine what parents *actually do* that helps or hinders their child's recovery. Examining patterns of parent-child communication in daily life and associations between these and children's recovery will help in developing targeted and tailored interventions.[9]

The child medical traumatic stress domain has only recently moved towards a greater focus on parents, and studies in this vein have mostly utilised retrospective self-report methodologies. Studies of parents' behaviour after a child's potentially traumatic experience via retrospective questionnaires or interviews are challenged by vulnerability to biases related to self-report, such as social desirability, recall bias, impression management, lack of self-knowledge and mental health status.[17] In addition, many daily behaviours are so subtle and natural that people have difficulty identifying and reporting on them. Many of these challenges can be overcome using an observational approach that measures daily parent-child interactions in real life. In fact, the general developmental and anxiety literature includes many real-time observational studies of parents interacting with their children; however these



are mostly families from the general population or clinical samples that are not necessarily trauma-exposed, participating in brief non-naturalistic observations (i.e. families are given a particular task and are taped).[18] In short, the traumatic stress literature has an evidence base that is on-topic but requires more detail and ecological validity to inform clinical practice, while the general developmental and anxiety literature has an evidence base that is detailed and rich but not trauma-specific nor in most cases entirely naturalistic.

A recently developed method, called the Electronically Activated Recorder (EAR),[19] provides an opportunity to gather detailed, naturalistic observational data on parent-child communication in the aftermath of injury, without placing a high burden on participants. The EAR is an ecological momentary assessment method which captures snippets of acoustic information from participants' daily life. Ecological momentary assessment refers to the repeated sampling of subjects' current behaviours and experiences in real time, in subjects' natural environments.[20] The EAR software operates on a small, unobtrusive device such as an iPod, and records snippets of ambient sound at pre-set random or regular intervals. It is one of the few ways to capture person-centred behavioural observational data in a natural environment. In particular, previous analyses showed that a) after a short habituation period, the EAR operates unobtrusively and minimally interferes with participants' normal activities; b) behavioural information can be reliably decoded from the sampled sounds; c) behavioural aggregates based on two days of monitoring show good temporal stability; and d) the periodic sampling pattern yields generalisable estimates of a person's daily behaviour (see [17]). When used in combination with questionnaires, the EAR has the advantage of minimising method variance.[17]

### Research aim and objectives

This study aims to describe the nature and **quantity** of parent-child communication after a child has been injured, and to examine how communication is related to children's psychological recovery, as well as other child, parent and family wellbeing variables. The findings will inform the development of clinical guidance to parents on how to help their child recover psychologically after injury. In particular, our main research objectives are to:

1. Characterise parent-child communication in the aftermath of children's serious injury;
2. Examine relationships between these parent-child communication patterns and children's psychological recovery.

## METHODS AND ANALYSIS

### Study design

The project is a prospective observational study. Children aged 3 to 16 years who have sustained a serious injury and their parents are enrolled at the Royal Children's Hospital Melbourne, Australia. This hospital is a tertiary children's hospital with a statewide paediatric trauma centre. Data are collected at:

1. *Baseline:* In-hospital (T1a), we collect questionnaire data regarding demographics, injury characteristics, child acute stress and parent acute stress. Shortly after discharge (T1b), we collect EAR recordings of two days of children's daily life at home.
2. *Follow-up:* At 6 weeks (T2) and 3 months (T3) post-injury we conduct structured telephone interviews regarding child and family outcomes.

### Eligibility criteria

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3 Families of children who have been hospitalised for at least 24 hours due to an injury (cf. [21])  
4 and are between 3 and 16 years of age are eligible, unless one or more of the following  
5 exclusion criteria apply: a) the injury has been, or is suspected to have been, caused by child  
6 maltreatment or self-harm; b) the family does not speak English in daily life (necessary for  
7 the coding of the EAR recordings); c) the child has sustained severe acquired brain injury  
8 (defined as a Glasgow Coma Scale [22] score < 9 at hospital presentation) and experiences  
9 continued impaired cognitive functioning at the time of approach (as decided by medical  
10 staff); d) the child is hospitalised for more than 4 weeks (we aim to measure parent-child  
11 communication within the first month post-injury); or e) the child's injury was secondary to  
12 an ongoing medical condition (e.g. a fracture associated with osteogenesis imperfecta).  
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### 15 **Recruitment and procedures**

16 Potential participants are identified on a daily basis via the RCH Emergency Department and  
17 inpatient hospital databases. Initial contact with children and families is made via an in-  
18 hospital visit by a member of the research team and an RCH Trauma Service staff member. A  
19 brief description of the study and an information flyer are given to the child and family. If the  
20 family expresses interest in hearing more about the study, a member of the research team  
21 provides further information and documents the informed consent of participants and families.  
22 Subsequently, demographic and injury data are retrieved from the medical records. Children  
23 and parents fill out the baseline questionnaires at their earliest convenience and are provided  
24 with the EAR (an iPod **Touch** pre-programmed with the EAR software). Children wear the  
25 EAR during the first weekend after discharge. At six weeks, and again at three months after  
26 the injury, psychological outcomes are assessed through telephone interviews with parents  
27 and with children if they are old enough.  
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### 31 **Assessments**

32 Table 1 shows the assessments used in the study. The most important measures regard the  
33 observed parent-child communication and children's stress reactions.  
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Table 1. Ear for Recovery study assessments

Constructs	Standardised Measures	T1 In-hospital or at home	T2 Phone interview 6 weeks post-injury	T3 Phone interview 3 months post- injury
Demographics & injury characteristics	AIS	x		
Child stress reactions	CRIES-13, CPSS	x	x	x
Child social support	MSPSS	x		
Child wellbeing	KIDSCREEN-27, SDQ		x	x
Parent-child communication at home	EAR	x		
Parental stress reactions	ASDS	x		
Parental optimism	LOT-R	x		
Parental self-efficacy	SDRP	x		
Parental wellbeing	SF-36		x	x
Family functioning	FACES-IV	x		

*Note:* AIS = Abbreviated Injury Scale; CRIES-13 = Children's Revised Impact of Event Scale; CPSS = Child PTSD Symptom Scale; MSPSS = Multidimensional Scale of Perceived Social Support; SDQ = Strengths and Difficulties Questionnaire; EAR = Electronically Activated Recorder; ASDS = Acute Stress disorder Scale; LOT-R = Life Orientation Test – Revised; SDRP = Screener for the Development of Response Posttrauma; SF-36 = Short-Form Health Survey; FACES-IV = Family Adaptability and Cohesion Evaluation Scale IV.

## Primary measures

### *Child stress reactions*

Children's stress reactions are measured with the Children's Revised Impact of Event Scale (CRIES-13)[23] and the Child PTSD Symptom Scale (CPSS),[24] for children aged between 8 and 16 years. The CRIES-13 measures intrusion, avoidance and arousal symptoms with 13 items on a 4-point scale. Reliability and validity of the CRIES-13 have been shown in several studies.[e.g.25] In one of our previous studies,  $\alpha$  was .85.[26]. The CPSS is a 24-item measure that can be used in structured interview format and yields a continuous severity score, an impairment score, and a probable PTSD status. The scale has shown excellent internal consistency, test-retest reliability and convergent validity,[24] and has been used successfully in medical child traumatic stress research.[4] To include at least minimal data on younger children, parents of children of all age groups are asked to rate on a visual analogue scale how upset their child was directly after the event and how upset the child is at the time of assessment.

### *Parent-child communication*

Families are loaned an EAR (a pre-programmed iPod Touch) to be used on the first feasible weekend after the child is discharged from the hospital. During two consecutive days, the injured child wears the EAR in a protective elastic belt on the outside of their clothes. Families are asked to keep a simple diary to identify the child's activities, who they are with, and any times the EAR is not worn by the child. The EAR records ambient sounds for 30 seconds every 5 minutes, from 7am to 10pm, totalling about 10% of the time. The sampling pattern yields about 160 sound files (80 min of recording) per person per day. This has been found sufficient to derive both reliable and valid data on people's unique communication patterns,[17,27] and by sampling only a fraction of the time, makes large observational studies feasible. The reliability, validity and unobtrusiveness of the EAR have been previously reported.[17,27,28] Transcription and coding of the EAR data is described below.

## Secondary measures

### *Demographics and injury characteristics*

Demographics, including family structure, are collected from the parents. Children's injury type (mechanism and general description) and severity (ISS; Injury Severity Score based on the Abbreviated Injury Scale)[29] are retrieved from the trauma registry of the RCH. Families are also asked whether one or both parents were present at the event that caused the injury, whether the child or a parent has been confronted with a traumatic event before, and whether the child or a parent has used mental health care services in the past 3 years.

### *Child social support*

Children's perceived social support is measured with the Multidimensional Scale of Perceived Social Support (MSPSS).[30] The 12-item measure reflects perceived support from family members, a special person and friends on a 7-point scale. Higher scores indicate more (perceived) social support. Reliability of the measure is high, as shown by a recent Australian study ( $\alpha = .90$ ).[31]

### *Child wellbeing*

The KIDSCREEN-27 [32] is used to assess the wellbeing of children aged 8-16 years. It is a 27-item instrument that covers five dimensions of quality of life on a 5-point scale: physical wellbeing, psychological wellbeing, autonomy and relationship with parents, peers and social

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3 support, and school environment. Validity and reliability are good [32, 33]. In addition,  
4 children are asked to indicate on a visual-analogue scale how happy they felt a week before  
5 the injury happened, how happy they feel currently and how happy they expect to feel in one  
6 month's time. Further information regarding child well-being in all age groups is gathered via  
7 parents answering the Strengths and Difficulties Questionnaire (SDQ) [34] at T2 and T3. The  
8 SDQ is a brief behavioural screening questionnaire about 3-17 year olds that is used often  
9 internationally. The reliability and validity of the SDQ have been described extensively [34].  
10 We use the Australian age-adapted versions (for 3 year old; 4-10 year old; and 11-17 year old  
11 children).  
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### 13 *Parental stress reactions*

14 The Acute Stress Disorder Scale (ASDS)[35] is used to assess parental acute stress reactions.  
15 The ASDS is a self-report scale with 19 items that measure acute stress according to the  
16 DSM-IV diagnostic criteria.[36] Parents rate the extent to which they have experienced each  
17 symptom since the injury of their child on a 5-point scale. The scale is reliable ( $\alpha = .96$ ) and  
18 has shown high sensitivity and specificity when compared with a diagnostic interview for  
19 Acute Stress Disorder.[35]  
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### 21 *Parental optimism*

22 Parental optimism is measured with the revised Life Orientation Test (LOT-R).[37] The  
23 measure has four 'filler' items that are not included in the score. The six remaining items  
24 measure participants' expectations about their future and their general sense of optimism on a  
25 5-point scale. Reliability of the scale is acceptable ( $\alpha = .75$ ) and its validity is well-researched  
26 and confirmed.[38] In addition, parents indicate on a visual analogue scale how happy or  
27 unhappy they feel and how confident they feel that they will be able to cope with a stressful  
28 situation.  
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### 30 *Parental self-efficacy*

31 Parental self-efficacy is measured by the 15 efficacy-focused items of the Screener for the  
32 Development of Response Posttrauma (SDRP).[39] The scale measures participants'  
33 confidence in their ability to cope with a potentially traumatic event, with higher scores  
34 reflecting higher confidence (when the items referred to 'ill/injured' children we only  
35 retained the word 'injured').  
36

### 37 *Parental wellbeing*

38 The Short-Form Health Survey (SF-36)[40] is used to measure parental wellbeing. The SF-36  
39 includes a single item measure of change in health status and a multi-item scale measuring  
40 each of the following eight health domains: physical functioning, role limitations due to  
41 physical health problems, bodily pain, general health, vitality, social functioning, role  
42 limitations due to emotional problems and mental health. Higher scores indicate higher levels  
43 of health and results can be divided into two aggregate scores: the physical component  
44 summary (PCS) and the mental component summary (MCS). Validity and reliability (PCS  $\alpha$   
45 = 0.92; MCS  $\alpha$  = 0.91) of the measure have been demonstrated comprehensively.[41]  
46

### 47 *Family functioning*

48 Family functioning is measured with the Family Adaptability and Cohesion Evaluation Scale  
49 IV (FACES-IV) [42] (parent report). The measure contains 84 items which assess high and  
50 low extremes of family cohesion and flexibility across six scales: balanced cohesion,  
51 balanced flexibility, enmeshed, disengaged, chaotic and rigid. Validity and reliability of the  
52 scales are good.[43]  
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## Data preparation and analysis

Handling of the data will be split into two broad stages: (1) EAR data preparation involving transcribing and coding as well as reliability checking and (2) statistical analysis involving EAR data and questionnaire data.

### Stage 1: EAR data preparation

EAR data preparation involves transcription and coding by trained research assistants receiving regular supervision. Each audio file (i.e. each 30 second segment) will be prepared by at least two transcribers/coders, allowing for corrections and reliability analyses. We expect to handle over 15,000 separate audio files.

#### *Transcribing*

Each audio file will be transcribed verbatim according to the guidelines of the computerised linguistic analysis program called Linguistic Inquiry and Word Count (LIWC).[44] The transcriptions will subsequently be aggregated and submitted to the LIWC software, which compares each word of a given text to a dictionary arranged into 74 categories (e.g. family words, sadness words) and reports total numbers of words and proportions of overall word use falling into the specific word categories.

#### *Coding*

Audio file coding will focus on parent-child interactions, children's activities and behaviours, and the topics and tone of conversations. The coding is manualised: a standardised behavioural coding scheme – a system that details acoustically-detectable aspects of participants' social environment and interactions adapted from previous EAR studies– will be used.[17] Each sound file will be coded for a) interaction (e.g. with how many people, who is talking); b) activity (e.g. watching TV, eating); c) mood/health of the child (e.g. laughing, crying, groaning from pain); d) topic of conversation (e.g. emotions/feelings, child rearing, injury related) and e) tone of conversation (e.g. 1 = very negative to 7 = very positive, with 4 being neutral; see Figure 1). As an example, with regard to interaction we will indicate for each audio file whether the child is alone or not, and in case of the latter, whether the child is a) interacting with one other person, b) interacting with a group (i.e. more than one person) or c) nearby other people (e.g. adults are talking among themselves a few meters away) but not interacting. If the child is interacting with one or more people, we will record the gender of the conversation partner(s).

Figure 1. Standardised behavioural coding scheme

#### *Reliability analyses*

The audio files will be coded by two research assistants, after which intercoder reliability will be calculated using intraclass correlations. Previous EAR studies have reported good reliability after coder training. For example in a recent study by Robbins et al., intraclass correlations for all coding categories ranged from .76 to .92.[45]

### Stage 2: Statistical analysis

Our main questions regard a) the nature and quantity of parent-child communication after paediatric injury and b) the relation between parent-child communication and children's psychological recovery.

#### *Nature and quantity of parent-child communication*

First, we will describe the sample in terms of mean scores, standard deviations and proportions. For example, we will examine the proportion of time that the children are interacting with others, and to what extent this figure varies across families. Second, we will identify typologies of parent-child communication using two-step clustering. Cluster analysis organises data into groups, or clusters. In particular, two-step cluster analyses are used to reveal natural, homogeneous subgroups within a dataset that may not otherwise be apparent.[46] It is a person-centred approach that is particularly suited for new areas of research. Each family will be allocated to one cluster based on statistical similarity within clusters and dissimilarity between clusters. For example, clustering can take place based on the following four variables: 1) the amount of time that parents spend with their children in the aftermath of serious injury, 2) the proportion of interaction time in which the injury or its consequences is discussed, 3) the proportion of positive interactions, 4) the proportion of negative interactions. We will test stability of the generated clusters by repeating the procedure with the sample split in two.[46] When a stable set of clusters has been generated, these will be interpreted and labelled by the research team. For example, a cluster could consist of 'withdrawn' parents (who may show low interaction, low injury discussion and low positive interactions).

#### *Associations with children's psychological recovery*

In order to understand which clusters of parenting behaviour are related to higher and lower levels of child posttraumatic stress, we will conduct analyses of variance. Parenting behaviour will be the independent variable (with the groups being compared as identified through the cluster analysis) and child posttraumatic stress score as the dependent variable (we will use the total symptom score of the CPSS). When significant, we will conduct multiple comparisons between groups with a Tukey-test.

#### *Secondary analyses*

In addition to these main analyses (clustering and associations with child stress outcomes), the data will allow for the quantitative and qualitative exploration of associations among communication factors and child, parent and family wellbeing.

#### **Sample size**

With regard to describing the nature and quantity of parent-child communication, means and proportions of behaviours can be described based on smaller sample sizes than inferential statistics. For clustering procedures, there is no generally accepted rule of thumb for minimum sample sizes. Formann advocates a sample size of at least  $2^m$ , where  $m$  equals the number of clustering variables, suggesting that large sample sizes are not required (e.g. 16 families if clusters were based on four variables).[47] In order to relate communication characteristics to subsequent outcomes, the sample size requirements would increase with the number of variables involved. Previously published EAR studies have conducted data analyses with samples sizes of approximately 50 families (e.g.[45,48]). As Finkel, Eastwick and Reis indicate, in this type of research, it is important to balance Type 1 and Type 2 errors.[49] The larger the sample size, the more fine-grained the analyses can be. We expect a sample size of approximately 70 families and intend to make the data available for future studies in order to ensure sufficient future sample sizes.

## ETHICS AND DISSEMINATION

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (study number 33103) and Monash University Human Research Ethics Committee (file number CF13/2515 - 2013001322). Signed informed consent is obtained from all participating families. We aim to disseminate the results of the study through international peer-reviewed journals, international conferences and social media. **Participants will be sent a thank you letter with a summary of the overall study findings.** In addition, depending on approval from the institutions involved, we aim to make de-identified data from the study available for secondary analyses by external researchers.

### Particular ethical considerations associated with EAR research

Mehl and colleagues [17] have previously highlighted a number of considerations specific to conducting EAR research such as issues of confidentiality when recording ambient sounds, and recording bystanders, discussed below.

#### *Recording bystanders*

The EAR records anything occurring in the acoustic environment of the child wearing it – anyone talking to, or talking near the child, including in public spaces, may be recorded. This means that some people recorded will not have provided written consent. As the recording takes place in the participant's natural environment shortly after hospital discharge, the majority of recordings take place in the home and involve immediate family members who are aware of the study. In order to ensure that bystanders are aware of the study, participants are asked to make the EAR visible by wearing it on the outside of their clothes with a 'RECORDING' label sewn onto the elastic belt. Participants and their parents are also advised to tell anyone coming into contact with the child over the recording weekend that the child is wearing the EAR. These steps, together, ensure that bystanders are aware of the potential of being recorded and therefore, in essence, passively consent to it. Along with the de-identification procedures described below, this makes it unlikely that the privacy rights of non-consented people who are recorded are violated.

#### *Privacy and de-identification*

The EAR is programmed to record only a small fraction of a person's day. Sampling occurs for 30 seconds every 5 minutes, allowing the EAR to "reliably extract basic behavioural information, yet [recordings] are short enough to capture only little contextualized personal information". [17] While the brevity of the sound files protects participants' privacy to a certain extent, identifying information is still often contained within them. Research team members involved in data preparation are trained to recognise and remove such information, including names, places and contact information. All identifying information is highlighted by researchers during the transcribing and coding process, and as each participant's recordings are transcribed and coded multiple times by separate researchers, there are multiple opportunities for identifying information to be detected. Any identifying information within audio recordings is then deleted by silencing the relevant sections of the sound file. During transcription, any identifying words are replaced by functional codes. For example, "Anna, can you turn the TV off?" becomes "[S1ster], can you turn the TV off?" Any written identifying information (for example names written within the participant diaries) is blacked out after use.



## DISCUSSION

While serious injury puts children's healthy development at risk, currently available early interventions have only been modestly successful in preventing the development of persistent posttraumatic stress symptoms.[4,9] With parents playing a central role in children's recovery,[3,16] targeting parental support behaviour appears to be an important avenue for improving early interventions.

The Ear for Recovery study differs from previous research in its use of an unobtrusive naturalistic observation device to collect objective data in family situations that normally would go unstudied or would rely on self-report. The outcomes of the current project will allow us to a) better understand families' experiences after child injuries and therefore improve professional interactions with families; b) indicate which parental behaviour may be helpful vs. unhelpful, leading to specific recommendations for future early interventions (learning from the successful behaviour patterns while targeting the unsuccessful ones); c) identify parents who may be in need of a tailored early intervention to help them support their child in the aftermath of a serious injury; and d) further develop the EAR methodology as a diagnostic tool in child (mental) health research.

An important challenge of this study regards the time-consuming and labour intensive process involved in handling the large volumes of audio data. It is possible that as technology develops there will be the opportunity to make use of advanced speech recognition software, however such software is not yet sophisticated enough to pick up on many of the subtleties that make up social interactions. A limitation of the current study is that we do not include an observation within the first few hours or day after the injury. It is possible that relevant parent-child interaction patterns take place in those first moments and become less frequent or prominent in the following days and weeks. In addition, an observation at the time points of the follow-ups were not feasible within the current study but would be of value for future research.

With the EAR methodology we will be able to provide a detailed characterisation of parent-child communication after serious injury. The current study aims to pave the way for better interventions to facilitate children's psychological recovery after serious injury. Implications may include exploring opportunities for use of the EAR methodology as a diagnostic measure in its own right and to inform other areas of child physical and mental health.

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**Contributors**

EA is the principal investigator of this study. EA, AB, FB, RC, RMC, VA and MM designed the study. EA, PB and AB drafted the manuscript. FB, RC, RMC, VA and MM provided feedback on the manuscript. All authors approved the manuscript.

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**Competing interests**

None

**Ethics approval**

This study has been approved by the Human Research Ethics Committee of the Royal Children's Hospital Melbourne (study number 33103) and Monash University Human Research Ethics Committee (file number CF13/2515 - 2013001322).

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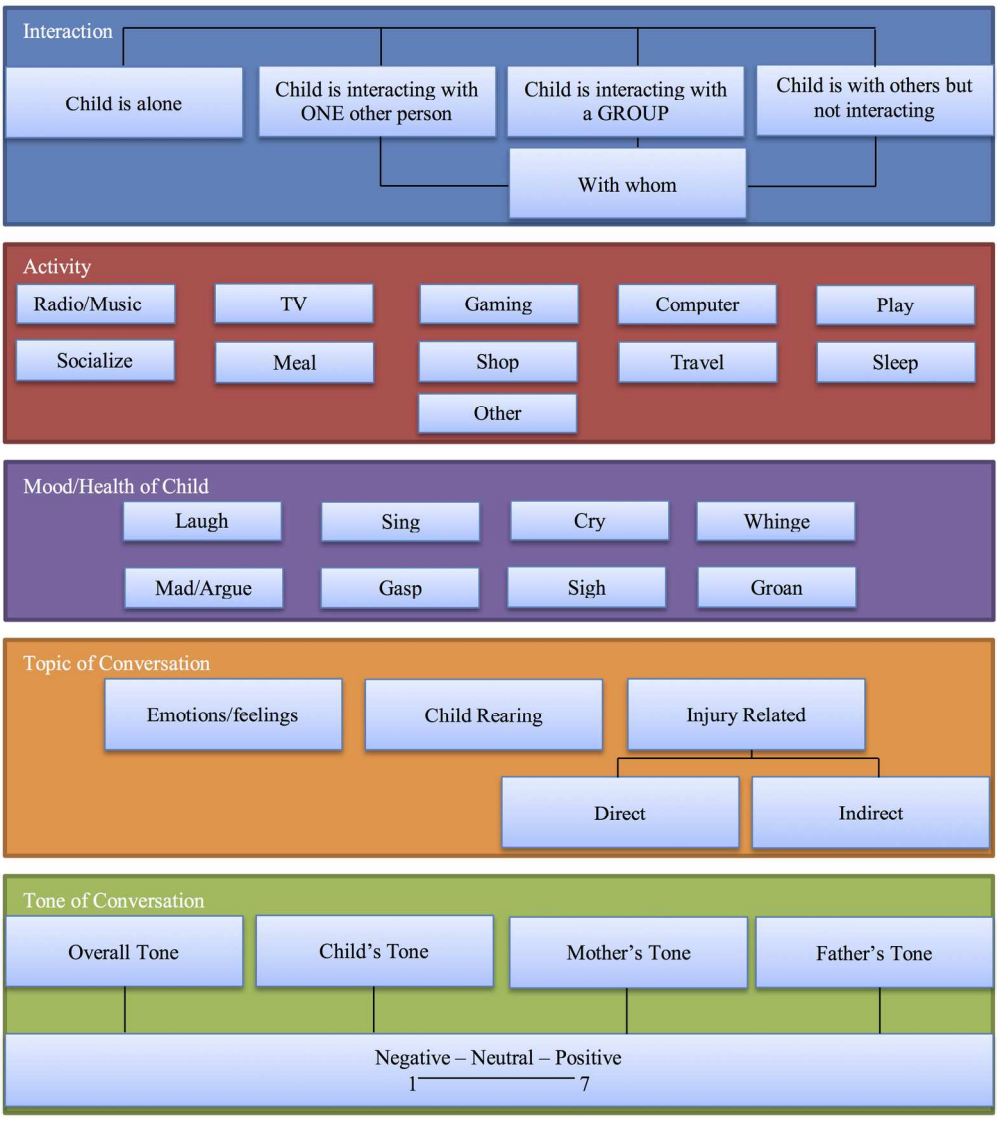
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