Helping infants and toddlers in Foster family care
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Salivary Cortisol
A possible biomarker in evaluating stress and effects of interventions in young foster children?

Based on:
ABSTRACT

Background: Young foster children undergo an early separation from their caregiver(s) and often experience severe stress before placement. However, a considerable part of the children do not show apparent signs of distress, making it difficult for the foster carer to be aware of the amount of stress in their foster child.

Objectives: Potential evidence for using salivary cortisol levels as a dimension to evaluate the amount of stress in young foster children is reviewed. Moreover, the applicability of salivary cortisol in the evaluation of stress-reducing interventions for young foster children is discussed.

Methods: A systematic review was performed using the databases Medline, Psychinfo, Embase, Ebscohost and Academic Search Premier.

Results: Nine studies were traced in which salivary cortisol was used to measure stress in children placed in family foster care or in adoptive families. Stress in general but also neglect, early loss of a caregiver, a younger age at first placement, and a higher number of placements were associated with an altered Hypothalamic-Pituitary-Adrenal (HPA) axis function in foster children. Moreover, four studies on the effect of stress-reducing interventions on HPA-axis functioning of young foster children were found. These studies suggest that caregiver-based interventions can actually help to normalize the HPA-axis function in foster children, and that such changes co-occur with improved behavioural functioning.

Conclusions: Although the results from the papers discussed in this review suggest that diurnal cortisol with a wake-up and a bedtime measurement may be a relevant tool to evaluate stress in young foster children, this cannot yet be concluded from the present for the following reasons. The statistical data from the studies on foster care and adoption in this review were not robust and researchers used different methods to collect the salivary cortisol.

Still, it is noteworthy that all studies did find the same pattern of reduced levels in relation to chronic stress (i.e., maltreatment of the child).

Key words
Stress, Cortisol, Hypothalamus-Pituitary-Adrenal axis (HPA-axis), Intervention, Foster children, Family foster care.
3.1 INTRODUCTION

Human infants, as well as many nonhuman primates, are entirely dependent on caregivers for their survival after birth. By the time the infant has the capacity to move away from the caregiver, normally he or she has developed an attachment bond with at least one primary caregiver. Given this function of the caregiver, it is not surprising that loss or inconsistency of the caregiver is associated with deregulation of (bio-)behavioural systems (Levine, 1983; Levine & Stanton, 1990; Suomi, 1999). Caregivers can alleviate and buffer infants’ stress. Infants who have experienced disruptions in care and have not yet bonded with substitute caregivers cannot derive the benefit from them in buffering their stress (Gunnar & Donzella, 2002). Children placed in foster care often have experienced disruptions prior to placement (Strijker & Knorth, 2009). As a result, children in foster family care often are unable to elicit proper caregiving (Stovall-McClough & Dozier, 2000). Specifically, under threatening conditions, foster children often may behave as if they do not need caregivers. At first glance many of these children seem to be well adapted to their foster family. They seem calm and behave unobtrusively while underneath subtle signs of deregulation and stress may be perceived. For example, behavioural deregulation can be seen when a frightened child does not seek its (foster) mother for protection, but instead moves away into a corner. Emotional deregulation cannot be observed, but may occur when a child experiences panic that is not relieved by the caretaker (Dozier et al., 2006).

Often, foster carers might be unaware of these forms of stress in the foster child, as they might not know the child well enough yet. As a result, the avoidant behaviour of the child may elicit complementary avoidant behaviour from foster carers (Stovall-McClough & Dozier, 2000). In this way, it is possible that a relationship is formed in which the stress of the foster child is not understood properly by the caretaker, and as a result the foster child may continue to feel insecure and has to cope with too high levels of stress. Pre-school age foster children are especially at risk because they have not yet developed sufficient (language) skills and other ways to express their stress. Chronic stress in turn is an important risk factor for disturbances in the development of the young child in general, and for the emotional development and a healthy and secure attachment in particular (Dozier et al., 2006; Dozier et al., 2002; Fisher et al., 2000).

Previous studies on foster family care have focused on psychosocial and behavioural measures of stress. Cicchetti and Gunnar (2008) emphasize the importance of integrating biological measures of stress for these young and vulnerable infants. The Hypothalamus-Pituitary-Adrenal (HPA-) system is the main biological system involved in the regulation of stress. The HPA-axis is activated in response to stress, resulting in the release of cortisol. Along with reactive features the HPA-system displays a circadian rhythm, with levels of cortisol being highest early in the morning and gradually declining during the day (Gunnar & Donzella, 2002). In individuals exposed to substantial early
adversity, the characteristic pattern of diurnal HPA-axis activity is altered (i.e., low or absent morning peak in salivary cortisol and low levels continuing throughout the day) (Gunnar & Vazquez, 2001). In the study of Luijk et al. (2009) infants with a disorganized attachment pattern showed a flattened slope of the diurnal rhythm as compared to securely attached children. A flattened daytime cortisol has also been found among children growing up in orphanages with structural neglect of basic emotional needs (Carlson & Earls, 1997; Gunnar et al., 2001). On the other hand, Cicchetti and Rogosch (2001) showed that sexually abused children with PTSD (Post Traumatic Stress Disorder) and a clinical level of internalizing (anxiety) problems were characterized by higher morning, higher afternoon and higher average daily levels of cortisol. No differences in diurnal variation of cortisol were found in neglected children without a history of (sexual) abuse, showing internalizing problems. A flattened circadian rhythm of cortisol was associated with a history of exposure to domestic violence and externalizing problems (Linares et al., 2007). A growing body of evidence suggests that atypically low levels of basal cortisol and flattened daytime rhythms have been shown to predict later general health problems and anxiety disorders in adults of both sexes (Heim et al., 2000; Yehuda et al., 2000), as well as antisocial and aggressive behaviour in boys (Vanyukov et al., 1993; McBurnett et al., 2000).

Thus, children exposed to substantial early adversity, such as early traumatic separation and/or abuse, may display altered patterns of HPA-axis regulation. Because early separation and/or maltreatment are nearly always present in the history of young (0-5 years of age) foster children (Greeson et al., 2012), it is plausible that they show HPA-axis deregulations. This review will focus on following questions: 1) Do young (0-5 years of age) foster children show HPA-axis deregulations, and if so is HPA-axis functioning - expressed by diurnal salivary cortisol - an adequate method to measure stress?; 2) Is it advisable and adequate to use diurnal salivary cortisol as an outcome measure in intervention studies in young foster children?

### 3.2 METHODS

We searched the following databases for papers published after 1978, the year in which the first study on the measurement of cortisol in saliva was presented (Walker et al., 1978), up to July 2012: Medline, Psychinfo, Embase, Ebscohost, and Academic Search Premier. We used three strings of index terms to search the databases. The first referred to cortisol and stress in children in general with key words like: ‘cortisol’, ‘stress’ and ‘children’. This yielded 1992 publications. A second string referred to foster children, using the key words: ‘young foster children’, ‘foster family care’ and ‘long-term foster care’. This search yielded 144 publications. Combination of block 1 and 2 yielded 124 publications. The third string of index terms referred to adopted children, with the key words: ‘young children’ and ‘adoption’. We decided to include ‘adoption’
as a term because adopted children, in general, have also been exposed to separation and substantial early adversity (Stams et al., 2000). The third string yielded 2487 publications. The combination of block 1 and 3 yielded 12 publications. The resulting 136 publications were subsequently screened on their relevance for the current review, using the following criteria:

- full text original articles, reporting on empirical research;
- use of biological markers of stress, especially HPA-axis functioning, measured with salivary cortisol;
- studies with a focus on long-term effects of stress and concerning adolescents were excluded;
- articles found in both searches, were counted only once.

Eight empirical studies (nine articles: two articles reported on the same data set and were considered jointly) that were relevant to our first research question were retained in this way. All eight articles were summarised using the following information: 1. Target group; 2. Sample size and age of the foster child; 3. Method of collecting cortisol samples; 4. Evaluation of cortisol outcomes (table 1).

To answer the question concerning salivary cortisol as an outcome measure in intervention studies in young foster children, we examined the same databases, combining the following key words in three strings of index terms (1. HPA; 2. Intervention; 3. Population): 1: ‘cortisol’, ‘salivary cortisol’, ‘diurnal rhythm of cortisol’; 2: ‘intervention’, ‘intervention effect’; 3: ‘preschool children’, ‘young foster children’, ‘foster children’, ‘foster family care’. We did not include the search term ‘adoption’ this time, because the dynamics of foster care (for example, in terms of attachment to the foster carers, contacts with biological parents, stress, length of stay in the foster home, and development of the child) differ in many ways with the dynamics in adoption (Lloyd & Barth, 2011). The combination of the three blocks in one final search yielded 11 hits, which were subsequently screened for their relevance, using the following selection criteria:

- use of a randomized clinical trial (RCT) design;
- focus on young (pre-school) foster children.

These criteria yielded four studies. All four articles were summarized using the following information: 1. Type of intervention to be studied; 2. Sample size and age of children; 3. Method of collecting cortisol samples; 4. Effects of the intervention on cortisol (table 2).

### 3.3 RESULTS

Table 1 summarizes the eight articles on HPA-axis activity in fostered and adopted children. Five studies (1,2,3,4,7) focused on family foster care, of which study 3 and 4 also reported on the use of a specific intervention. Three studies (5,6,8) were directed at adopted children as target group.
Table 1: Evaluation of salivary cortisol values in eight studies on young children in foster or adoptive families

<table>
<thead>
<tr>
<th>Authors</th>
<th>Target group</th>
<th>Sample (N, Age)</th>
<th>Method of cortisol measurement</th>
<th>Cortisol evaluation</th>
<th>Statistical outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bernard et al., 2010</td>
<td>Children in foster families</td>
<td>In foster care, n=184 In home of origin with extra help, n=155 Controls, n=94 2,9-31,4 months of age</td>
<td>Circadian, measured twice during two days at home at wake up and bedtime</td>
<td>Lower Cortisol Awakening Response (CAR) in foster children as compared to controls</td>
<td>Effect: significant Intercept: p=.002 Sample Slope: p=.001</td>
</tr>
<tr>
<td>2. Dozier, Manni et al., 2006</td>
<td>Children in foster families</td>
<td>Foster children, n=55 Non-fostered controls, n=104 20-60 months of age</td>
<td>Circadian, measured twice in a day in two consecutive days at home at wake up and bedtime</td>
<td>Young children entering foster care showed more often atypical rhythms (flattened as well as elevated curves)</td>
<td>Effect: significant Intercept: p≤ .01 Sample Slope: p≤ .05</td>
</tr>
<tr>
<td>3. Fisher et al., 2000</td>
<td>Children in foster families</td>
<td>EIFC a, n=10 RFC b, n=10 Controls, n=10 54-65 months of age</td>
<td>Circadian, measured thrice in a day in two days at home: wake up, mid morning and bedtime</td>
<td>Atypical patterns of cortisol in the FC c groups (flattened as well as elevated curves)</td>
<td>Effects not significant because of small groups</td>
</tr>
<tr>
<td>4. Fisher &amp; Stoolmiller, 2008</td>
<td>Children in foster families (MTFC-P) d</td>
<td>Intervention, n=57 Care as usual, n=60 Community, n=60 36-72 months of age</td>
<td>Circadian, measured twice (wake up and bedtime) in two consecutive days, once a month during 12 months at home</td>
<td>More often flattened curves in foster children</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>5. Gunnar et al., 2001</td>
<td>Children in adoptive families</td>
<td>Adopted after 8 months, n=18 Adopted before four months, n=15 Controls, n=27 60-144 months after adoption</td>
<td>Circadian, measured thrice in a day during three days (awakening, noon, bedtime); 6,5 years after adoption at home</td>
<td>Higher levels of cortisol in the group of children that was adopted after eight months of age compared with the other two groups</td>
<td>Significant: p&lt; .05</td>
</tr>
</tbody>
</table>
Table 1: Evaluation of salivary cortisol values in eight studies on young children in foster or adoptive families (Continued)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Target group</th>
<th>Sample (N, Age)</th>
<th>Method of cortisol measurement</th>
<th>Cortisol evaluation</th>
<th>Statistical outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Gunnar et al., 2008</td>
<td>Children in adoptive families</td>
<td>Children with low stress levels, n=38 Children with moderate stress levels, n=44 Children with severe stress levels, n=42 120-150 months after adoption</td>
<td>At home on two schooldays after school and also in a laboratory after a challenging situation</td>
<td>No salivary cortisol response to the challenging situation in all groups</td>
<td>Significant: p&lt; .001</td>
</tr>
<tr>
<td>7. Linares et al., 2007</td>
<td>Children in foster families</td>
<td>History of maltreatment before placement, n=21 72-150 months of age</td>
<td>Circadian, measured thrice (awakening, at four in the afternoon, bedtime) in a day during a weekend, at home</td>
<td>Absence of morning peak of salivary cortisol</td>
<td>Not significant</td>
</tr>
<tr>
<td>8. Van den Dries et al., 2010</td>
<td>Children in adoptive families</td>
<td>Formerly family fostered children, n=42 Formerly children in institutions, n=50 11-16 months of age</td>
<td>Circadian, measured thrice in a day (awakening, before lunch bedtime) during one ordinary day</td>
<td>No difference in cortisol patterns between the two groups 2-6 months after adoption</td>
<td>Not significant F (4,107) = 0.36</td>
</tr>
</tbody>
</table>

a EIFC = Early Intervention Foster Care; b RFC = Regular Foster Care; c FC = Foster care; d MTFC-P = Multidimensional Treatment Foster Care for Pre-Schoolers
3.3.1 Period of being in care

In the studies of Dozier et al. (2006, 2008) the children recently had been placed in foster family care, in the other studies (Fisher et al., 2000; Fisher et al., 2008; Linares et al., 2007; Bernard et al., 2010) it was not clear how much time existed between the placement and the time of sampling of salivary cortisol.

3.3.2 Diurnal cortisol rhythm

Research from Bernard et al. (2010) indicated lower cortisol values at awakening and flatter patterns of salivary cortisol production from waking to bedtime in CPS-involved (Child Protection Services) children. The largest deregulation in salivary cortisol patterns was found in CPS-involved children who continued to live at home. Foster children showed less disturbance when compared with this group of CPS-involved children who still lived at home, but more disturbance when compared with controls. Dozier et al. (2006) and Fisher et al. (2000) found both patterns of low and high cortisol production in foster children aged 20 tot 60 months, compared with children who were never in foster family care. Linares et al. (2007) found a pattern of low morning cortisol and low evening cortisol in foster children with a history of maltreatment before placement in foster care. Gunnar et al. (2001, 2008) and Van den Dries et al. (2010) examined the effect of adoption over time on patterns of salivary cortisol. Gunnar and colleagues found differences in salivary cortisol when children were being placed in adoption after less or more than eight months of institutional care. These differences (more often abnormal salivary patterns with longer stay in orphanage) seemed to exist over time. Van den Dries et al. (2010) compared salivary cortisol levels in adopted children with a history of foster family care and institutional care. They did not found a difference in patterns between these two groups.

3.3.3 Ways to collect salivary cortisol

In the study of Bernard et al. (2010) four cortisol samples were taken (two at awakening and two at bedtime in two days) from each child at the foster home. Dozier et al. (2006) also collected four cortisol samples at home, but they also used ‘compliance caps’ to capture the exact time the vial was opened. The cotton used was dipped in a vial containing 0.8 gr of flavored beverage crystals cherry flavored to promote salivation. In the study of Linares et al. (2007) foster mothers gathered six salivary samples across two weekend days. Timing of samples was verified by telephone report and diary recordings. Van den Dries et al. (2010) collected three samples in one ordinary day. The samples were collected half an hour after the child woke up, before lunch and in the evening, half an hour before the child went to bed.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Intervention Studied</th>
<th>Sample (N, Age)</th>
<th>Methods of cortisol measurement</th>
<th>Intervention effect</th>
<th>Statistical effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dozier, Peloso et al., 2006</td>
<td>ABC, Comparison group (DEF)</td>
<td>ABC, n=30 DEF, n=30, 20-60 months</td>
<td>Circadian, thrice daily in two consecutive days at home</td>
<td>Normalisation cortisol diurnal rhythm in intervention group (ABC)</td>
<td>F(1,46)=4.55, p=0.04</td>
</tr>
<tr>
<td>Dozier et al., 2008</td>
<td>ABC Comparison group not in foster family care</td>
<td>ABC, n=46, DEF, n=47, Not in foster care, n=48, 20-60 months of age</td>
<td>Cortisol response to Strange Situation Procedure (SSP)</td>
<td>Normalisation of cortisol response to SSP in intervention group (ABC) as compared to the control group (DEF)</td>
<td>Effect Size 0.22: a small effect</td>
</tr>
<tr>
<td>Fisher et al., 2000</td>
<td>EIFC</td>
<td>EIFC, n=10 Regular foster family care, n=10 Community control, n=10, 3-6 years of age</td>
<td>Circadian, thrice daily in two ordinary days at home</td>
<td>Normalisation diurnal rhythm cortisol in intervention group (EIFC)</td>
<td>Trends in the effect for time F(4,11)=4.0, p=0.10 and trends for the group by time interaction F(10,22)=2.18, p=0.10</td>
</tr>
<tr>
<td>Fisher et al., 2007</td>
<td>MTFC-P</td>
<td>MTFC-P, n=57 Comparison: 60 Community: 60, &lt; 65 months</td>
<td>Circadian, twice in two consecutive days, once a month during 12 months at home</td>
<td>Normalisation of daytime rhythm of salivary cortisol in intervention group</td>
<td>Effect Size: MTFC versus RFC: 0.65, a medium effect</td>
</tr>
</tbody>
</table>

Table 2 summarizes the four studies on the effects of various interventions on cortisol rhythms. All studies used a Randomized...
Controlled Trial design and had young foster children as the target group. The study by Dozier et al. (2006) is a preliminary study, preceding another study by the same team (2008).

### 3.3.4 Interventions

The **ABC intervention** (Attachment Biobehavioral Catch-up) (Dozier et al, 2006) is designed to help children with behavioural problems to develop regulatory capabilities. It targets three specific issues. Foster children tend to give behavioural signals that may lead even nurturing caregivers to provide non-nurturing care. The intervention therefore firstly aims to help caregivers learn to reinterpret children’s alienating behaviours, helping caregivers to over-ride their own issues that interfere with providing nurturing care, and providing an environment helping foster children to develop regulatory capabilities. The second aim is to help caregivers who are not comfortable with providing nurturance. Third, foster children are at risk for behavioural and bio-behavioural dysregulation as the result of disrupted relationships with previous caregivers. The intervention aims to help children to regain bio-behavioural regulation (Dozier et al., 2002). Results showed that the ABC-intervention may have a normalizing effect on salivary cortisol day rhythms as well as a normalizing effect on the response to the Strange Situation Procedure (Dozier et al., 2006, 2008).

The **EIFC intervention** (Early Intervention Foster Care) (Fisher et al., 2000) is a short, preventive intervention designed to reduce risk in preschool-age foster children. First, EIFC examines the parenting strategies used by foster carers. The training and support provided to foster carers is intended to help them to use strategies that have been empirically documented to lead to more positive outcomes for children (Patterson et al., 1992). These strategies include (1) consistent, non-abusive discipline; (2) high levels of positive reinforcement; and (3) close monitoring and supervision of the child. The first study of Fisher et al. (2000) was a pilot study of the EIFC-intervention with ten children in the experimental group. EIFC starts before the child is being placed in the foster family with an intensive pre-service training of the foster carers. After placement foster carers receive support and supervision through daily telephone contacts, weekly home visits and weekly support group meetings together with other participating foster carers. Fisher et al. (2006) concluded that the EIFC-intervention may have a normalizing effect on salivary cortisol and that such changes co-occur with improved behavioural functioning.

The later work of Fisher et al. (2007) was an effect study focused on the **MTFC-P intervention** (Multidimensional Treatment Foster Care for Preschoolers). It was directed at newly placed foster children. MTFC-P originates from evidence concerning the effectiveness of behavioural parent training approaches and a clinical need for programs to address the behaviour of delinquent adolescents who have been found to be beyond parental
control (Fisher et al., 2007). This approach has been successful in foster family care with young severely behaviourally disturbed children. It is a family-based intervention to address the developmental and social-emotional needs of foster pre-schoolers. To be eligible for the study, the placement had to be expected to last for at least three months. The MTFC-P programme was at random assigned. The placements included both first time placements as well as moves and re-entries into family foster care following breakdown. Monthly early morning and evening cortisol levels were assessed over twelve months. Fisher et al. (2007) found a normalization of cortisol diurnal rhythm in the intervention group.

The way cortisol was measured differed per study, also the designs of the studies were diverse. Considering the opportunities to conduct a statistical meta-analysis it proved impossible to create a joint database on cortisol because the articles described different methods to collect the salivary cortisol. For example, Dozier et al. (2008) measured salivary cortisol in a lab situation: the ‘Strange Situation Procedure’ (Ainsworth et al., 1978) was used. In the other studies circadian measurements of salivary cortisol, collected in the foster home, were used. Some researchers collected two samples a day, others collected three samples. Also the way in which the cortisol specimen was collected differed (using flavoured or non-flavoured cotton swabs). Furthermore, researchers did not systematically report on the time of measurement of salivary cortisol, nor on the length of time children were living in the foster family.

3.4 DISCUSSION

The aim of this study was to provide an overview of research on 1) the HPA-axis deregulations in young foster children and whether these deregulations – expressed by diurnal salivary cortisol – is an adequate method to measure stress in these children, and on 2) salivary cortisol outcomes as a measure of the effectiveness of interventions for young children in family foster care.

We reviewed eight studies on foster care concerning the HPA-axis functioning, expressed by diurnal salivary cortisol. In sum, it appeared that cortisol measurements have been used in research concerning stress in young fostered and adopted children (Dozier et al., 2006; Gunnar & Vazquez, 2001; Van den Dries et al., 2010). The characteristic pattern of alterations noted for these children was a flattening of diurnal (morning-to-evening) cortisol activity which was largely due to low early morning cortisol levels (Bernard et al., 2010; Gunnar & Vazquez, 2001). Fisher et al. (2000, 2008) found the same pattern of low morning and low evening diurnal cortisol in the group of foster children before intervention. A pattern of low morning cortisol and low evening cortisol was also seen more often in (foster) children with a history of maltreatment (Bernard et al., 2010; Linares et al., 2007).
We reviewed four studies on the use of salivary cortisol to evaluate the effectiveness of interventions for young children in family foster care. All studies considered the effects of intervention in children below six years of age. Each of these studies used a RCT design to measure the effect of the intervention. And all interventions were specifically designed to be used in family foster care. The studies showed that, by supporting more responsive, competent caregiving, some of the early adversity effects of stress seem to be reversible. All interventions resulted in a normalisation of the salivary cortisol circadian rhythm after intervention. However, it should be noted that only small groups participated in the studies. The statistical outcome was not robust. Only in one study a medium effect size was found. Therefore little can be concluded about long-term effects. As with every review on published studies, publication bias may play a role, as studies are more likely to become published when the results are supportive of the effectiveness of the intervention studied. Further studies including larger samples and also including long-term effects are needed to confirm the positive results. Still, it is remarkable that all four studies showed normalisation of salivary cortisol circadian rhythms. Considering long(er) term outcomes in adopted children comparable findings on cortisol rhythms were found. One might ask if there are one or more common elements in the interventions, also present in the environment of an adopted child, which might explain this effect.

A common element in the interventions focuses on empowering the foster carer and helping the foster carer to better understand and regulate the child. Deregulation of the child may occur when the relationships are disrupted or when caregivers are unable to provide responsive care. All reviewed interventions aim to help foster carers grow in their ability to understand the child, to act in a proper way in regard to the (insecure) history of the child, and to help the child regulate his or her behaviour. By empowering the foster carer the child is also helped. Systematically implemented and developmentally well-timed interventions might have the potential to change developmental trajectories and to promote resilience (Dozier et al., 2006).

It is also noted that several studies provided evidence that ‘caregiver-based intervention’ can help normalize the HPA-axis function in young foster children and that such changes co-occur with improved behavioural functioning (Fisher et al., 2006). Dozier et al. (2006) described a similar finding on improved behaviour but this effect only tended to be statistically significant in their study. These findings suggest a positive relation between improved behaviour of the child, normalisation of salivary cortisol rhythm and quality of foster care. The HPA-axis seems to remain mutable over time and actually might be influenced by therapeutic interventions and other environmental changes (Fisher et al., 2011). Another explanation for the normalisation of cortisol rhythms might be found in the way the stress system adapts over time. The studies concerning long term effects on cortisol rhythm in adopted children indicate that salivary cortisol patterns seem to
normalise over time (Gunnar et al., 2008; Van den Dries et al., 2010). It is yet unclear
how to interpret this finding. It may be caused by factors in the child itself (the studies
(Gunnar et al., 2008; Van den Dries et al., 2010) seem to illustrate that the human stress
system adapts to stress in time with a normalisation of cortisol rhythms as a result).
It may also be influenced by factors linked to the adoptive parents like ‘competence’,
‘dealing with stress’ and ‘being able to ask for help’ (Tirella et al., 2012). It is yet unclear
whether this is applicable for foster children. The research groups on interventions in
foster care were small and no follow up measurements were done. It may be possible
that interventions in foster care only have a short term positive effect on salivary
cortisol outcomes and behaviour of the child. Further research is needed to examine
the possible relation between the qualities of the caregivers and the effect on stress in
the child in the short and long term.
Considering the use of salivary cortisol to measure stress the review shows that in
seven studies a circadian measurement was used, one study used the Strange Situation
Procedure (Dozier et al., 2008), and one study combined a measurement at home with
a challenge in the lab (Gunnar et al., 2008). The circadian measurement most often
showed differences in salivary cortisol in relation to stress. A positive relation with a
history of maltreatment and with the mental state of the child could be determined
as well. Researchers use different methods to collect the specimen of salivary cortisol:
sometimes twice a day, sometimes thrice a day, often two days in a row. Samples were
collected in the home of the child on moments the child is as relaxed as possible.
That is why this seems to be the ‘measurement of choice’. However, two studies used
a challenging situation (Dozier et al., 2008; Gunnar et al., 2008) to measure stress. One
might ask: is there a ‘best’ method? We think that when evaluating possible intervention
effects in young children one can use a challenging situation to measure the effect on
salivary cortisol and also the diurnal rhythm of salivary cortisol is possible as an indicator.
Our review indicated that a twice-a-day-measurement of diurnal cortisol is a useful
method to evaluate changes in the circadian rhythm of salivary cortisol. The “wake
up” measurement is the most significant in this regard, because the CAR (= Cortical
Awakening Response) seems to decrease most in children with chronic stress (Bernard
et al., 2010; Dozier et al., 2006; Fisher et al., 2000). An additional advantage of this method
is that it is less stressful for the child. Parents can do it themselves following a written
instruction, the procedure is not invasive for the child, and it is less stressful for the child
than travelling to a laboratory (Pierrehumbert et al., 2009). It is not recommended to
collect only one sample of salivary cortisol in the morning because if a pattern in which
both high levels of cortisol in the morning and in the afternoon is present (which may
point to underlying anxiety states) (Cicchetti & Rogosch, 2001), this will be missed.
Moreover, research on salivary cortisol in general populations shows there are many
variables relating to the measurement of cortisol in saliva which may introduce error,
and therefore may render difficult the comparison and interpretation of data between and within laboratories. This may induce erroneous interpretations of Type I and Type II (Hansen et al., 2008).

The other way to test the human stress system is by using a challenge. Gunnar et al. (2009) reviewed the effect of possible challenging stressors in this regard. It became clear that although a challenging stressor may appear to be stressful, it does not always produce a significant increase in cortisol levels in children. This may be due to various reasons. Cortisol levels may already be increased even before starting the lab tests. This can be the case in healthy children and also as the child suffers from an underlying psychiatric disorder (Brand et al., 2011). It is also possible that the trip to the laboratory invokes increased cortisol levels in the child (Pierrehumbert et al., 2009). Gunnar et al. (2009) advised to study the challenging stressor first. Challenges are not always carefully crafted and tested to be sure if the challenge actually stresses the child. Furthermore, Gunnar et al. (2009) concluded it rarely occurred that the challenging situation had been examined against control conditions in which the same or other children experienced conditions that were comparable but did not involve stress-provoking tasks. Possibly this is also the explanation for the finding in the study of Gunnar et al. (2008) on children in adoptive families; no salivary cortisol stress response was measured to a challenging situation. It seems clear that using a challenge is possibly a sound method to test the reactivity of a child’s stress system.

We focused on studies regarding foster children from zero to six years of age. The stress system is not yet fully matured. In this context research on stress in animals shows that separation at an early age in rodents and other mammals seems to have the most profound effect on subsequent HPA-axis development. During the first two weeks of life rat pups show a markedly reduced adrenocortical response to stress after having been separated from their mother (Sapolsky & Meaney, 1986).

This interval in the course of the rat pup development is known as the Stress Hypo Responsive Period (SHRP). During this interval there is a notable lack of reaction of the HPA-axis to external stressors. The presence of high levels of glucocorticoids due to stress during this period of time may have a negative impact on the development in this system. The regulation of the HPA-axis response that occurs during the SHRP is thought to be largely caregiver mediated (Rosenfeld et al., 1992; Smotherman & Bell, 1980). It is thought that the absence of a responsive, supportive caregiver serving as an external extension of the child’s regulatory system may have negative long-term effects on the child, especially during this period of HPA-axis development (Fisher et al., 2006). This could be a major risk when a child has been placed in foster family care at a time when it is especially susceptible for caregiver regulation. Further research is needed regarding this possibly iatrogenic effect of a foster care placement at a vulnerable moment in the development of a child.
Another issue concerns the question at what age the stress system is fully matured. Researchers report a large variation in the age of appearance of the ‘adult’ expression of the circadian rhythm, varying from as early as two months till the age of nine months (Antonini et al., 2000; Edwards et al., 2001; Kiess et al., 1995; Larson et al., 1998; Lewis & Ramsey, 1995; Price et al., 1983; Santiago et al., 1996; Spangler & Grossmann, 1993). Gunnar and Donzella (2002) concluded that significantly lower mid-afternoon than mid-morning levels (which are characteristic in adult curves) cannot be obtained reliably until children are around four years of age. They hypothesized that the lack of significant decreases in infant cortisol during the daytime hours is associated with infants’ sleep/wake pattern, characterized by daytime napping.

For this reason, the age span (0-5 years of age) of foster children who participated in the studies described may be rather broad. Differentiation in subgroups 0-9 months of age, 9-24 months of age, and 24-48 months of age would be advisable because the possible effects of the SHRP on stress and further maturation of the stress system may influence the outcomes on salivary cortisol and stress. More research will be necessary to address this topic.

Although the results from the papers discussed in this review suggest that diurnal cortisol with a wake-up and a bedtime measurement may be a relevant tool to evaluate stress in young foster children, this cannot yet be concluded from the present for the following reasons. First, there are many variables relating to the measurement of cortisol in saliva in general which may introduce all kinds of error and therefore may render difficult the comparison and interpretation of data between and within laboratories. This may induce erroneous interpretations of Type I and Type II (Hansen et al., 2008). Second the statistical data from the studies on foster care and adoption in this review were not robust and third researchers used different methods to collect the salivary cortisol. Still, it is noteworthy that in all studies researchers did find the same pattern of reduced levels in relation to chronic stress (i.e., maltreatment of the child).

Research on the use of salivary cortisol to evaluate the effect of interventions targeting stress in foster children tends to show a positive effect of interventions on the stress system with normalisation of salivary cortisol rhythms as a result. Long term effects are not clear. It is possible that the stress system always adapts over time with a normalisation of diurnal rhythms. It is not yet clear how to weigh results on salivary cortisol outcomes. It seems best to consider them as results in addition to other indicators of stress.
3.5 IMPLICATIONS

More research will be needed to develop a uniform way of using salivary cortisol in foster care research. Consensus should be reached on how to measure salivary cortisol, how many measurements suffice and how to interpret the results. It is advisable to develop standardised international protocols. This will make comparison of results easier and it will increase the evidence base on salivary cortisol in foster care research.

In addition, this review showed that (1) age differences in fostered children, (2) time of placement in foster care, (3) duration of foster care before measurement and before the start of the intervention, and (4) severity of the maltreatment and/or abuse before placement, are all factors that may influence the results of interventions. Researchers as well as clinicians should take these kind of variables into account in their future work.
REFERENCES


