A Novel Approach to the Rehydration of Children with Gastroenteritis in the Emergency Department

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Abstract

Background

Children with gastroenteritis comprise 6% of all Emergency Department presentations and with growing pressure to complete care in six hours, a rehydration Best Care Bundle (BCB) was created to deliver evidence based but timely interventions to children presenting to the emergency departments (ED) at Waitemata District Health Board (WDHB).

Method

A modified systematic review was undertaken to validate the interventions in the BCB and to identify additional interventions from the best available contemporary evidence. A search was executed through Medline, Cinahl and Scopus focussing on the last 5 years and those studies published in English.

Results

Forty one articles were retrieved and appraised; the outcome measures were collated and compared with the BCB interventions. The use of a categorical hydration assessment scale and the components thereof were consistent with contemporary best practice although the evidence suggests that clinical sign based scales have better sensitivity than specificity and are most accurate for predicting severe dehydration. The use of (low osmolality) oral rehydration solutions (ORS) to rehydrate mild to moderately dehydrated children was confirmed to be effective and associated with fewer adverse effects than intravenous fluids (IVF). The BCB promotes nasogastric (NG) rehydration in young children with dehydration but not severe dehydration where oral rehydration therapy (ORT) failed and was shown to reduce the need for IV fluids. IV fluids were found to be associated with higher admission rates, length of stay and revisit rates; the latter was noted regardless of severity of disease. There is little evidence but general agreement that intravenous fluids (IV) are warranted for severe dehydration with signs of shock (Schutz, Babl, Sheriff, & Borland, 2008; Simpson & Teach, 2011). There is scant evidence for the most effective volume or rate of rehydration but rapid rehydration over 4 hours was found to improve

the discharge rates without an increase in adverse events and revisits. The use of intravenous fluids containing 5% Dextrose and 0.9% Sodium Chloride IV fluids was found to be effective at correcting serum ketone levels with fewer incidences of hyponatraemia when compared with hypotonic solutions. Ondansetron administration was associated with fewer ORT failures, lower requirements for IV fluids, reduced admission rates and reduced length of stay in ED. Parental advice to continue/resume normal feeds early was associated with earlier cessation of diarrhoea than clear fluids alone or diluted feeds; advice to avoid high sugar foods was supported by historical evidence that high sugar ORS increased duration and volume of diarrhoea.

Other possible interventions that warrant further examination include: the use of lactose free feeds, probiotics, zinc and Racecadotril to reduce the duration of diarrhoea; also subcutaneous fluids as an alternative to IV fluids in the under-3 age group. Finally, some small studies for the objective assessment of hydration (such as digital capillary refill or serum ketones) show promise but further work is required to confirm initial findings and to develop a meaningful clinical application.

Conclusions

The WDHB hydration BCB contains interventions that are evidence based and the structure is likely to promote earlier disposition decisions, which should have a positive impact on ED LOS, admission rates and revisits but this has yet to be measured empirically.

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Abbreviations

ADH - Antidiuretic hormone

AGREE - The Appraisal of Guidelines for Research and Evaluation

BCB – Best Care Bundle

BMJ – British Medical Journal

CASP - Critical Appraisal Skills Programme

CEBM - Centre for Evidence Based Medicine

CNS – Clinical Nurse Specialist

CS – Cohort Study

ED – Emergency department

EE – Economic evaluation

ESPGHAN - European Society for Paediatric Gastroenterology, Hepatology and Nutrition

GRADE - Grading of Recommendations Assessment, Development and Evaluation

Hr - Hour

IV – Intravenous

IVF – IV fluids

IVL – IV leur/catheter

Kg - Kilogram

LOS - Length of stay

Mg - Milligram

MLs – Millilitres

NG – Nasogastric

NGT– Nasogastric tube

NICE – National Institute for Clinical Effectiveness

NS – Sodium Chloride 0.9% or normal saline

NSD5 - Sodium Chloride 0.9% or normal saline plus 5% Dextrose

NSH - North Shore Hospital

ORT – Oral rehydration therapy

ORS – Oral rehydration solution/fluid

PCNS – Paediatric Clinical Nurse Specialist

PICo – Phenomenon, Intervention and Comparison group

PICO – Phenomenon, Intervention, Comparison group and Outcome

QALYS – Quality of Life Adjusted Years Score

RHR - Rapid rehydration rate

RCT - Randomised Control Trial

RCHFSC - Recombinant human hyaluronidase-facilitated subcutaneous

SC - Subcutaneous

SCBU - Special Care Baby Unit

SMO – Senior Medical Officer

SPP - species

SR – Systematic review

SRR - Standard rehydration rate

UK - United Kingdom

USA – United Stes of America

WHO – World Health Organization

WTH - Waitakere Hospital

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Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor any material which to a substantial extent has been submitted for any other degree or diploma of a university or other institute of higher learning."

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Ethics Approval

Ethics approval was neither sought nor required for this study as there were no human participants, and the research did not include the use, collection or disclosure of health information or human tissue (as defined by the Health Information Privacy Code and Human Tissue Act 2008 respectively). Furthermore, there was no use of a database or funding body that required ethics approval.

This dissertation also contains no materials that breach confidentiality of any persons.

Chapter One: Introduction

Background

Gastroenteritis in the developed world may not be associated with significant child mortality but it nevertheless comprises 6% of all presentations to the paediatric emergency department (ED) in Australasia and it is one of the leading causes of hospital admissions in the under-five age group (Acworth et al., 2009; Matson, 2015a; Matson et al., 2012). The causative organisms are primarily viral in this context, although bacterial causes are also seen (Das, Salam, & Bhutta, 2014; Fischer Walker, Fontaine, & Black, 2013; Graves, 2013; Thapar & Sanderson, 2004). Children with gastroenteritis present with symptoms of diarrhoea often with accompanying vomiting, anorexia, myalgias, abdominal pain and fever; the type and severity of symptoms varies with the causative organism and the host's age and constitution (Desselberger & Gray, 2013; Matson, 2015a). Ongoing fluid and electrolyte losses can result in volume depletion or hypovolaemia[1] (Bianchetti, Simonetti, & Bettinelli, 2009). Infants and young children are at increased risk of hypovolaemia as they have both a higher turnover of water but also a higher proportional total body water and extracellular fluid ratio than older children or adults (Bianchetti et al., 2009; Sterns, 2015). In addition, young children are less likely or able to self-correct dehydration as they have a reduced capacity to respond to thirst (Bianchetti et al., 2009; Peruzzo et al., 2010). Hypovolaemia, if uncorrected, can lead to shock, organ failure and ultimately death and thus gastroenteritis treatment is primarily concerned with: identifying children with life threatening volume depletion, initiating prompt and appropriate repletion therapy, establishing and supporting ongoing fluid requirements and finally determining which children may be safely managed at home or will require admission for ongoing fluid therapy and/or surveillance (Craven, Campbell, & Martin, 2009; D'Agostino, 2006; Di Lorenzo, 2015; Fleisher, 2015; Freedman, Thull-Freedman, Rumantir, Atenafu, & Stephens, 2013; Gallagher, 2003; Matson, 2015a, 2015b; Somer, 2015b; Wildi-Runge, Allemann, Schaad, & Heininger, 2009).

[1] It should be noted that the terms dehydration and volume depletion are often used synonymously however dehydration in the strict sense refers to the loss of water alone whereas extracellular volume depletion relates to water and salt loss volume depletion, the terms will be used interchangeably throughout this review.

In the ED, there is an additional onus on clinicians to complete care and/or make disposition decisions (admit or discharge) early. Length of stay (LOS) is a commonly used quality measure and in 2009 the New Zealand government introduced a target that 95% patients will be discharged or transferred within six hours (Ministry of Health, 2015). Hence, care delivered in the ED must be timely as well as effective. Oral rehydration therapy (ORT) is widely advocated as the mainstay of rehydration for children with mild to moderate dehydration as it is safe, effective and reduces the need for intravenous fluids (IVF) and hospital admission (Alam et al., 2011; Atia & Buchman, 2009; Binder, Brown, Ramakrishna, & Young, 2014; Freedman, 2015; Goodall, 2014). Surprisingly, it remains underutilised in both primary and secondary care despite this (Alam et al., 2011; Freedman, Sivabalasundaram, et al., 2011; Lee & Haden, 2007; Ng, Lo, & Lee, 2009; Ozuah, Avner, & Stein, 2002; Pelc et al., 2014; Vecchio et al., 2014). Clinical guidelines theoretically offer management approaches to guide treatments that are based on sound evidence (Barth et al., 2012; Cates et al., 2001; Graham, 2014; Grol & Grimshaw, 2003; Timmermans & Mauck, 2005). However, as Van den Berg and Berger (2011), found in their critical review of nine gastroenteritis guidelines, there is considerable variance between guidelines both in terms of their content and quality (Van den Berg & Berger, 2011).

Other issues include the fact that many gastroenteritis guidelines are long, complex and can require intricate calculations; an aspect that makes them less user friendly in practice and this may explain why individual clinicians tend to use guidelines they are familiar with (Carlsen, Glenton, & Pope, 2007; Chow, Leung, & Hon, 2010; Fox, Richards, Jenkins, & Powell, 2012; Freedman, Sivabalasundaram, et al., 2011; Graham, 2014). Disparate approaches to rehydration can mean that nursing staff are less able to anticipate or commence fluid regimens and unfamiliar prescriptions may also result in delays (whilst prescriptions are checked, clarified and executed) or even administration errors (Dougherty, Sque, & Crouch, 2012; Eisenhauer, Hurley, & Dolan, 2007; Elliott & Liu, 2010; Mattox, 2012). Accordingly, the adoption of one guideline within an ED seems likely to improve consistency, familiarity and safer administration of fluids and in the case of gastroenteritis may increase the use of ORT.

It is well described that the adoption and uptake of a clinical guideline can be problematic and common barriers include: lack of awareness or agreement, feasibility or applicability concerns and lack of managerial support, (Aftab et al., 2014; Boehnert, Zimmermann, & Exadaktylos, 2009; Guyatt, Oxman, Kunz, et al., 2008; Safeek & Safeek, 2009; Sanderlin & AbdulRahim, 2007). These barriers may be overcome in part by widespread dissemination and promotion by clinical leadership and addressing practical issues such as ensuring pertinent medications, resources or equipment that are required within the guidelines are available (Clark, 2003; Goode, Fink, Krugman, Oman, & Traditi, 2011; Graham, 2014). Other more pervasive barriers centre on the attitudes and beliefs of individual physicians, many of whom dispute the assertion that standardised care leads to improved outcomes for all, arguing that "cookbook medicine" does not meet the needs of patients with unique circumstances and over time may erode physicians' diagnostic and clinical skills or even prestige (Clark, 2003; Goodman, 2011; Maue, Segal, Kimberlin, & Lipowski, 2004; Spallek et al., 2010). They also cite the lack of compelling evidence that guidelines improve outcomes. With reference to gastroenteritis, some studies have shown no or modest improvements after the introduction of a guideline or pathway but these publications are relatively scarce and are often not of high quality or have poor generalisability (Altimier, Brown, & Tedeschi, 2006; Doan, Chan, Leung, Lee, & Kissoon, 2010; Phin, McCaskill, Browne, & Lam, 2003). Even where physicians agree with clinical guidelines in principle, it may be difficult to persuade them to use anything but their preferred guideline (Aftab et al., 2014; Cabana et al., 1999; Carlsen et al., 2007; Clark, 2003; Grol & Grimshaw, 2003; Hader et al., 2007; Safeek & Safeek, 2009; Spallek et al., 2010; Stoneking, Denninghoff, Deluca, Keim, & Munger, 2011; Timmermans & Mauck, 2005; Van Dijk, Hooft, & Wieringa-de Waard, 2010).

In the ED environment there are additional challenges arising from the pressure on time. The longest delay in ED is often waiting to be seen by the clinician and consequently treatment initiation (even if it is driven by a guideline) may be delayed, resulting in a prolonged LOS (Ieraci, Digiusto, Sonntag, Dann, & Fox, 2008; Laskowski, McLeod, Friesen, Podaima, & Alfa, 2009). This has been addressed through the use of clinical pathways, whereby treatment (based on a clinical guideline) is initiated by nursing staff and these have been shown to be effective in reducing ED LOS and increasing patient satisfaction for

some conditions (Boehnert et al., 2009; Chin et al., 2002; Dalcin et al., 2007; Doan et al., 2010; Doherty, Jones, Davis, Ryan, & Treeve, 2007). Another effect is that nurse initiated treatment in some ways circumvents physician resistance to guidelines/pathways, as the care has already been commenced by the time they are involved (Doherty et al., 2007). The creation and adoption of a clinical guideline or pathway is obviously a complex issue; even if the guideline is well written, based on credible evidence and is widely disseminated. Mindful of the above, the paediatric ED team at Waitemata District Health Board (WDHB) have attempted to improve quality, consistency and promote nurse initiated care for children with gastroenteritis through the creation of a rehydration Best Care Bundle (BCB). The following sections will describe the clinical context at WDHB, introduce the BCB, and present the rationale for this study.

Clinical Setting, BCBs and Study Rationale

WDHB is comprised of two hospitals and several community-based services and in terms of population, it is the largest DHB in New Zealand. The bigger of the two hospitals (North Shore (NSH)) has a full range of services but no inpatient paediatric wards. Paediatric presentations to the NSH ED comprise about 7% of the overall number; these children are seen by generalist ED clinicians. Waitakere Hospital (WTH) is a smaller hospital with limited services and an inpatient paediatric ward. 30% of the WTH ED presentations are paediatric which includes referrals to the paediatric medical team and who are seen in the ED. In addition to the medical paediatricians, there are two ED paediatricians and a team of Paediatric Clinical Nurse Specialists (PCNS) who care for children at WTH ED. When the ED paediatricians are not present, generalist ED consultants oversee the care of children. Within WDHB, paediatric innovations are implemented firstly at WTH (as there are higher numbers of patients and paediatric clinical staff) before being implemented at NSH. Local data revealed considerable disparity between individual clinician's approaches to common paediatric presentations as reflected by length of stay and admission rates. It is also well described that paediatric physicians tend to deliver care to children that is more consistent with contemporary evidence and areas that see higher numbers of children tend to be more compliant with evidence based care (Nunez, Liu, & Nager, 2012; Vecchio et al., 2014). Given that the paediatric ED consultants are not always present to address

treatment disparities, the BCBs were developed to guide practice for certain presentations.

BCBs are a collection of resources, including treatment pathways, designed to reduce process delays in the ED and to provide a framework for the delivery of evidence based, standardised treatment. They differ from clinical guidelines in that there are timed assessment and treatment points and interventions are stipulated based on assessment scores and/or progress since last assessment. They are largely nurse initiated, providing inclusion criteria are met and this ensures that treatment is commenced before the clinician [2] sees the patient. Other BCB components include a workbook for nursing staff, pertinent standing orders, an underlying evidence document, PCNS competencies (to enable them to undertake the clinician role), specific clinical records and parent handout/s (the Rehydration BCB is included in Appendices A-J). The implementation of each BCB was preceded by a period of education of both nursing and medical staff, preparation of the documents and securing access to necessary medications/fluids. This served to publicise the BCB, show support at the service/clinical leadership level and ensure that there were no practical obstructions to its use. Three respiratory BCBs have been implemented at WTH and internal audits of one of them have demonstrated reductions in length of stay, time to treatment and admission rates. However, when the same BCB were introduced at NSH, the project team tracked children's presentations for the first few months and they found that there were many issues. These included: eligible children not being placed on a BCB, clinicians removing them from a BCB that the nurse had initiated, or that the interventions were not executed as per BCB. It is believed that this is largely due to the fact that smaller numbers and proportion of children are seen at NSH and consequently, the nursing staff and physicians were not able to develop confidence in the BCBs. In addition, the lack of paediatric SMOs and PCNSs at NSH has meant that the BCBs were inconsistently championed in practice and that pervasive scepticism went unchallenged. This suggests that the impetus to change previous practice has not been sufficient to overcome the barriers in this setting.

[2]At WTH ED *clinicians* refers to CNSs (who undertake the whiteboard clinician role i.e. are assigned as the clinician on the electronic whiteboard) or doctors

The rehydration BCB was implemented at WTH in March 2015 and the variance in uptake with the respiratory BCB suggests that a different approach is needed to ensure compliance with the BCB at NSH. Regarding the BCBs, it was commented that the underpinning guidance document was too long and there was too little supporting evidence, or it was not clear how the evidence had informed the interventions. This may reflect confusion about the difference between a guideline and a BCB. Credible clinical guidelines are derived following the systematic appraisal of the evidence and the inclusion of evidence based treatments. A BCB is a vehicle to structure the *delivery of care* which is usually derived from an existing guideline or other evidence. For the conditions of asthma, croup and bronchiolitis (the three respiratory BCBs) there are several credible guidelines and/or reasonable agreement in the literature as to their management. Accordingly, these BCBs contained largely accepted treatments, albeit in a repackaged framework, for the delivery of nurse initiated care. In contrast, for gastroenteritis, there is far less consensus within the literature and the treatment in ED is more complex than for the respiratory conditions. The Rehydration BCB therefore includes interventions from a variety of sources and some of the elements may be seen as controversial. In addition, as the underpinning guidance document contains only references for sources that were used and not those that were rejected, it may be seen by dissenters that wider evidence was not considered. It is, therefore necessary to demonstrate that the Rehydration BCB reflects best contemporary evidence based practice. To this end, a modified systematic review will be undertaken to validate the Rehydration BCB interventions, to identify additional or alternative interventions that could or should have been included and to create an evidence summation to augment the BCB guidance document.

The report is presented in five chapters. Chapter One has introduced the study and its rationale. Chapter Two examines the literature related to the management of gastroenteritis in children and how this has informed the development of the rehydration BCB. In Chapter Three, the methodology and methods used in this modified systematic review are described. The findings of the review will be presented and discussed in Chapters Four and Five including how the interventions in the rehydration BCB were either validated or refuted as well as additional possible interventions identified for inclusion. Finally, Chapter Five will also discuss the implications for practice and will include a

summary of the empirical basis for bundle interventions, which will be used in the education phase of the rehydration BCB prior to its implementation at NSH. In addition, issues that require further study will be highlighted as well as emerging innovations or treatments that may be considered for future inclusion in the rehydration BCB.

Chapter Two: Literature Review

This Chapter will provide an overview of the contemporary management of gastroenteritis as described in the literature. The pathophysiology of gastroenteritis will be examined, followed by a summary of the current approaches to the treatment of gastroenteritis and how this is reflected in the rehydration BCB interventions.

Pathophysiology of Gastroenteritis:

The World Health Organization (WHO) definition of diarrhoea is the passage of 3 or more, loose watery stools in 24 hours, but this may be interpreted flexibly if the stool output is significantly different from usual in terms of volume and/or consistency (Thapar & Sanderson, 2004). Diarrhoea arises from an imbalance between normal absorption and secretion in the small intestine. In adults, up to 10L/day passes through the gut and most of this is absorbed back into the blood stream with a normal stool fluid output being around 150mL/day (Kent & Banks, 2010; Thapar & Sanderson, 2004). In gastroenteritis, absorption can be reduced and/or secretion may be increased; the degree of each again depends on the causative agent (Corcoran, van Well, & van Loo, 2014; Diggle, 2007; Fletcher et al., 2013; Parashar, Nelson, & Kang, 2014). For instance, rotavirus targets and lyses absorptive enterocytes that line the intestinal mucosa, consequently, absorption is impaired, cryptal secretory cells become predominant and secretion is increased; furthermore many of the chemicals produced in response to inflammation are pro-secretory which exacerbates the issue (Thapar & Sanderson, 2004). The increased intraluminal contents and thus volume, increases peristalsis leading to reduced transit times which further contributes to fluid loss in the stool (Kent & Banks, 2010).

The exact mechanism for vomiting (or forced expulsion of stomach contents via the mouth), in gastroenteritis is not fully understood (Di Lorenzo, 2015). The favoured explanation is that the vomiting centre, located in the lateral reticular formation of the medulla oblongata, is stimulated via the vagus nerve. It is not clear whether this is through direct peripheral stimulation of the vagus nerve or through stimulation of the serotonin 5-hydroxytryptamine 3 (5HT3) receptors in the gastrointestinal tract in response to intestinal irritation or a mixture of both (Chow et al., 2010). The chemoreceptor centre

may also contribute to the activation of the vomiting centre in gastroenteritis (Das, Kumar, Salam, Freedman, & Bhutta, 2013). The vomiting centre, once activated triggers the cascade of diaphragm, stomach and abdominal contractions that are associated with vomiting (Chow et al., 2010). Nausea is attributed to decreased gastric tone that often precedes vomiting and is again due to stimulation of serotonin 5-HT3 receptors in both the small intestine and the chemoreceptor centre (Chow et al., 2010).

Losses from diarrhoea are usually isotonic but there can still be a net overall loss of potassium, water or sodium. Compensation for hypovolaemia involves increasing the production of antidiuretic hormone (ADH) which acts to reabsorb water in the renal tubules and this can also lower serum sodium levels through dilution (Emmett & Palmer, 2015). With some causative agents the sodium content of the stool is reduced which results in disproportionate losses of water and ensuing hypernatraemia (Somer, 2015a; Sterns, 2015). Hypovolaemia leads to reduced tissue perfusion and an increase in non-aerobic cellular metabolism and lactic acid production (Lamont & Crean, 2014). The kidneys attempt to reabsorb more sodium in the proximal tubule to preserve intravascular fluid but this reduces the amount of sodium in the distal tubule available to assist with acid excretion; both of these compensatory mechanisms in conjunction with the loss of salts, anions and bicarbonate in the stool contribute to a metabolic acidosis (Emmett & Palmer, 2015). Excessive vomiting without diarrhoea can conversely, lead to metabolic alkalosis due to excess loss of acid (Di Lorenzo, 2015). To further complicate the issue, reduced intake may lead to a starvation state whereby glucose and glycogen stores are depleted and metabolism of fatty acids occurs to provide cellular fuel (Emmett & Palmer, 2015; Reid, McQuillan, & Losek, 2003). These by-products of alternative metabolic pathways result in ketone production (ketosis) and may also contribute to metabolic acidosis. Hence, diarrhoea and vomiting can lead to hypovolaemia, hypokalaemia, hyponatraemia, hypoglycaemia, ketosis, metabolic acidosis and less commonly metabolic alkalosis or hypernatraemia.

Current Approaches to Treatment

If hypovolaemia and the resulting metabolic acidosis are not remedied, organ perfusion will be reduced leading to organ ischemia then failure, which can ultimately prove fatal

(Peruzzo et al., 2010). Hypoglycaemia and hyponatraemia can also lead to coma, seizures and death if uncorrected (Peruzzo et al., 2010). Accordingly, the main treatment objectives are to identify, treat and prevent dehydration and associated electrolyte imbalances; it is particularly important to recognize children with severe dehydration as they require prompt corrective therapy (Graves, 2013). Initial management must also include ruling out alternative differential diagnoses that can present with similar symptoms such as intussusception, acute otitis media or toxic megacolon (Fleisher, 2015). In the ED there are also the more pragmatic goals of promoting timely resolution of dehydration and discharge in order to meet ED length of stay targets and to the reduce the costs associated with hospital admissions (Bruzzese, Vecchio, & Guarino, 2013; Cheng, 2011; Ciccarelli, Stolfi, & Caramia, 2013; Colletti, Brown, Sharieff, Barata, & Ishimine, 2010; The Pediatric ROTavirus European CommitTee (PROTECT), 2006).

A necessary first step is to assess the degree of dehydration which is generally stratified as follows: mild dehydration is commonly described as being a loss of 3-5% of body weight (which is a proxy measure of fluid loss), moderate dehydration relates to 6-10% fluid loss and severe is anything above 10% (Das et al., 2014; Gavin, 2006; Royal Children's Hospital Melbourne, 2015; Van den Berg & Berger, 2011). The most objective method is to calculate weight loss; for instance, if a child who previously weighed 10kg has lost 500g in weight, this equates to 500 millilitres (mLs) in fluid volume or a 5% volume loss (Somer, 2015a). However, clinicians rarely have an accurate and reliable pre-illness weight so this is often not clinically feasible and so other methods are required in practice (Canavan & Arant, 2009; Hopper, 2010).

Clinical signs such as pulse rate, blood pressure, mucous membrane evaluation, capillary refill, respiratory rate and depth, skin turgor and urine output are all likely to change with hypovolaemia and therefore theoretically they could be used as an alternative marker of dehydration. However, they are also affected by other factors such as pain, crying, fever, ambient temperature, drinking or mouth breathing and many studies have shown that the assessment of some signs is highly subjective with poor interrater correlation (Canavan & Arant, 2009; Parkin, Macarthur, Khambalia, Goldman, & Friedman, 2010; Steiner, DeWalt, & Byerley, 2004). Furthermore, it has proven difficult to validate correlations between

clinical signs and precise degrees of dehydration. Delayed capillary refill, reduced skin turgor and deep respirations have been found to be the most reliable predictor of 5% volume depletion but more so when used in combination (Canavan & Arant, 2009; Somer, 2015a; Steiner et al., 2004). Combining clinical signs into dehydration scores such as the WHO dehydration Scale, the Gorelick Dehydration Score, and the Clinical Dehydration Scale have attempted to improve diagnostic accuracy (Bailey, Gravel, Goldman, Friedman, & Parkin, 2010; Pringle et al., 2011; World Health Organization, 2005) (see appendix K). However, external validity trials have consistently shown that whilst there is generally good sensitivity (ability to correctly rule in dehydration) these scores perform less well in terms of specificity (ability to correctly rule out dehydration) (Bailey et al., 2010; Canavan & Arant, 2009; L. Chen, Kim, & Santucci, 2007; Falszewska, Dziechciarz, & Szajewska, 2014; Freedman, Vandermeer, Milne, & Hartling, 2015; Goldman, Friedman, & Parkin, 2008; Gorelick, Shaw, & Murphy, 1997; Jauregui et al., 2014; Milani et al., 2013). This means that dehydration may be over-diagnosed using these scores.

It should also be noted that the diagnostic accuracy of the scores was found to increase with severity of disease suggesting that it is easier to detect severe dehydration and more difficult to discern mild or moderate dehydration based on clinical signs (Freedman, Vandermeer, et al., 2015). Historically, the exact degree of dehydration was necessary as it was used to calculate rehydration fluids based on mL for mL replacement administered over 1-2 days. However, given the difficulties with diagnosing the exact degree of dehydration without an accurate pre-illness weight and the fact that the resulting fluid regimens are complex, this approach has gradually fallen out of favour. More recently dehydration assessment has evolved into a more categorical approach whereby the child is judged to be "*not dehydrated", "dehydrated"* or "*severely dehydrated"* based on clinical signs in combination with a history of recent losses and/or poor intake (Somer, 2015a). This places less emphasis on the exact degree of dehydration and reflects a more flexible and pragmatic approach; the advent of standardised rehydration regimens complements this approach as will be discussed further on. A categorical assessment is used in the rehydration BCB (see Fig 1).

Figure 1: Hydration Assessment Tool

Hydration Assessment Tool (HAT)	
Features suggesting dehydration. (Any combination of these) • Reduced urine output • Recent weight loss • Thirsty • Absent tears • Sunken eyes	**Features suggesting severe dehydration / shock.** (Any combination of these) • Tachycardia, small volume pulses • Delayed Capillary Refill Time • Cool peripheries, • Limp and drowsy

Blood testing can also be used to assess hypovolaemia with serum bicarbonate being the most useful laboratory determinant of hypovolaemia. Blood urea nitrogen (BUN) increases in dehydration but is a less specific marker as it also increases with bleeding or catabolic metabolism (Somer, 2015a). Blood testing can also identify derangements in electrolytes but these may be normal in mild to moderate dehydration and therefore, are only helpful in the management of children with severe dehydration. Given that severe dehydration is discernible from clinical signs and that blood testing is invasive, distressing and costly, most guidelines, including the BCB (see appendix C), do not recommend their use to diagnose dehydration and they are only indicated if IV fluids are commenced (Milani et al., 2013; Parkin et al., 2010). Furthermore, IV access is more difficult to achieve in children and so relying on blood work to make a diagnosis is likely to delay rehydration (Somer, 2015a; Spandorfer, 2011; Spandorfer et al., 2012). Other methods for assessing dehydration such as ultrasound scanning, urinalysis, bladder scanning and predictive weight calculations have been explored but none are currently widely recommended (Steiner et al., 2004; Steiner, Nager, & Wang, 2007). It should be noted that the clinical assessment of electrolyte imbalance is a separate issue that will only be addressed where it relates to dehydration within this study.

Having ascertained whether a child is "*not dehydrated", "dehydrated"* or "*severely dehydrated"* the BCB outlines the care required according to their needs (see Table 1and Appendix C).

Table 1: Summary of BCB Treatment Pathways

Not Dehydrated
Main Treatment Goals: • To demonstrate child can tolerate adequate oral intake without significant ongoing losses. • Prompts discharge decision after 1 hour.
Dehydrated
Main Treatment Goals: • Rapid rehydration, oral if possible, if hourly oral target is not met or feasible then nasogastric (NG) or IV fluids are mandated. • Also includes assessment of ongoing losses. • Prompts disposition decision at 4 hours. Children who have ongoing losses, are still dehydrated, require ongoing NG or IV fluids are referred to the paediatric medical team for possible admission.
Severe Dehydration
Main Treatment Goals: • Urgent medical review and repletion therapy • 20mL/g 0.9% Sodium Chloride boluses given until clinical signs improve • Care is individualised

Any rehydration regimen needs to consider the appropriate route of rehydration as well as the type, volume and rate of fluids to be administered and these issues will be considered in turn starting with the most effective route of rehydration. There is general agreement that enteral rehydration (i.e. oral or NG) is as effective as IV rehydration for mild to moderate dehydration and is associated with fewer risks and adverse outcomes (Alam et al., 2011; Atia & Buchman, 2009; Binder et al., 2014; Chow et al., 2010; Craven et al., 2009; Dalby-Payne & Elliott, 2011; Freedman, 2015; Larson & Melnyk, 2000; Nager & Wang, 2002; Spandorfer, Alessandrini, Joffe, Localio, & Shaw, 2005; Works, 2014). Some authors would go as far as to say that the enteral route is superior as it restores intestinal function sooner and so terminates diarrhoea earlier, although this is not a widely held view (Rimon & Freedman, 2010). Therefore, enteral rehydration with Oral Rehydration Solution (ORS) is recommended in the BCB (see Appendix C) and in many clinical guidelines for gastroenteritis including: National Institute for Clinical Guidelines (NICE), European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN Europe), Royal Melbourne Children's Hospital, Starship Clinical guidelines and the World Health Organization (WHO) (Gavin, 2006; Guarino et al., 2014; NICE guidelines, 2009; Royal Children's Hospital Melbourne, 2015; World Health Organization, 2005). Some authors also state that severe dehydration can also be corrected enterally but there is less

empirical evidence for this in the context of gastroenteritis and most guidelines currently endorse IV rehydration for this group (Canavan & Arant, 2009; Carcillo, 2014; Guarino et al., 2014; Lamont & Crean, 2014; Rouhani, Meloney, Ahn, Nelson, & Burke, 2011).

There are, however some issues with ORT; children must be prepared to drink and carers must be prepared to promote its consumption at volumes that exceed normal intake and it is thus labour intensive (Boyd, Musuttil, & Stuart, 2005; Candy, 1987; Craven et al., 2009; Karpas, Finkelstein, & Reid, 2009; Li, Klein, Tarr, & Denno, 2009; Nir, Nadir, Schechter, & Kline-Kremer, 2013). Nausea and/or ongoing vomiting may make the child less willing to drink and the carers less willing to promote fluids and is the most commonly cited reason for ORT failure (Bruzzese et al., 2013; B. Carter & Fedorowicz, 2012; Cheng, 2011; Fedorowicz, Jagannath, & Carter, 2011). Studies have shown that parents actually prefer IV rehydration to oral with the most likely reason being that they are not battling with their child as IV rehydration is easier to administer once a cannula has been inserted, it may also reflect a perceived vindication of their decision to attend the ED (Craven et al., 2009; Hopper, 2010; Karpas et al., 2009; Nir et al., 2013). There are multiple studies that have shown that oral Ondansetron significantly reduces nausea and promotes cessation of vomiting and it has been shown to reduce ORT failure rates, admission rates and length of stay in ED (Edmonds, 2009; Freedman, Adler, Seshadri, & Powell, 2006; Freedman, Hall, et al., 2014; Golshekan, Badeli, Rezaieian, Mohammadpour, & Hassanzadehrad, 2013; Hervás, Armero, Carrión, Utrera, & Hervás, 2012; Weinstein & Seupaul, 2011). Ondansetron is a serotonin 5-hydroxytryptamine 3 (5HT3) antagonist (New Zealand Formulary for Children, 2016). It acts by blocking the impulses sent to the chemoreceptor centre and the vomiting centre that trigger the vomiting reflex (Schnadower, Finkelstein, & Freedman, 2015; Vreeman, 2009; Woolley & Burton, 2009; Yilmaz, Yildizdas, & Sertdemir, 2010). The BCB recommends the use of Ondansetron for ongoing nausea and vomiting in order to promote ORT success.

The efficacy of ORT is due to the composition of ORS which has over time been adjusted to achieve the optimal amount of water uptake by the intestines; modern ORS contains a sodium concentration of between 40 to 90 mmol/L, a glucose concentration between 110 to 140 mmol/L and an osmolarity of about 290 mOsm/L (Shapiro, Wallace, & Roth, 2010).

ORS exploits the co-transport of sodium as glucose is taken into the intestinal cells which is not disrupted during diarrhoea (Freedman, 2015). The uptake of these two solutes increases the intracellular concentration resulting in a net movement of water into intestinal cells via osmosis and this is how rehydration occurs (Atia & Buchman, 2009). Fluids that contain high amounts or glucose or sodium in the intestines encourages water to move or stay in the lumen of the intestine and may actually increase stool volume (Unger et al., 2014).

Whilst sodium is necessary, it can make ORS unpalatable to children and this can lead to ORT failure (Passariello et al., 2015; Passariello et al., 2011). Pharmaceutical companies have created a range of rehydration fluids in a variety of flavours, yet despite the empirical links between taste and ORT success, only one solution is subsidised for use in New Zealand, Pedialyte Bubble Gum® flavour. Despite the fact that other flavours may be more popular the BCB pragmatically uses this fluid as alternatives would incur a significant cost. Furthermore, flavour becomes less of an issue when used in the NG route. This has led to the development of a unique instructional element within the rehydration pathway of the BCB that directs nurses to evaluate the likely success of ORT both at the start and in subsequent assessment points (at 60 and 120 minutes). If the child is refusing to drink or is unable to meet target volumes, NG rehydration is prompted using ORS. Hence, IV rehydration is only indicated if dehydration is severe or if NG rehydration is unfeasible (for instance, in older children who may be too large or vigorous to allow tube placement and/or to keep the tube in situ).

IV rehydration is more complex, if shock is present there is consensus that bolus doses (10-20mL/kg) of isotonic saline solutions (for instance 0.9% Sodium Chloride (NS)) should be given until the signs of shock improve (Noone, 2012; Van den Berg & Berger, 2011). This is reflected in the BCB which states that "*0.9% Sodium Chloride should be administered in doses of 20mL/kg to correct shock"*. Historically, maintenance IV fluids for children were hypotonic in terms of sodium and included glucose as they were originally devised to replicate the components of breast milk (Lamont & Crean, 2014). However, it is now understood that children experiencing physiological stress, including gastroenteritis, increase their ADH production promoting water conservation and thus there is growing

agreement that isotonic solutions are more suitable to prevent acquired hyponatraemia (Neville, Verge, O'Meara, & Walker, 2005; Sterns, 2015). Indeed, hypotonic fluids have been shown to reduce serum sodium levels in children with previously normal serum sodium levels which justifies this assertion (Bianchetti et al., 2009; Hanna & Saberi, 2010; Hoorn, Geary, Robb, Halperin, & Bohn, 2004; Lamont & Crean, 2014; McNab et al., 2015; Peruzzo et al., 2010). Concerns about giving isotonic fluids to children with hypernatraemia have been raised but isotonic fluids prevent rapid falls in serum sodium (which is to be avoided to prevent cerebral fluid shifts) and it is suggested that correcting intravascular depletion allows the kidneys to self-correct serum sodium levels (Somer, 2015b; Sterns, 2015; Wathen, MacKenzie, & Bothner, 2004).

The addition of glucose to isotonic NS has been found to correct the ketosis associated with starvation in gastroenteritis more effectively and has also gained recent popularity (Somer, 2015b; Sterns, 2015). Young children are known to have decreased glycogen stores and often become hypoglycaemic in response to physiological stress and so the addition of glucose seems reasonable (Lamont & Crean, 2014). Hence, the BCB includes the use of 0.9% Sodium Chloride plus 5% Dextrose (NSD5) for IV rehydration.

Having discerned the preferable route and type of fluids, the volume and rate of rehydration is another factor to consider. As mentioned previously, rehydration historically occurred over 1-2 days. Rapid rehydration regimens over 4 hours have been more recently evaluated and found to be at least as effective as standard rehydration, with no increase in adverse events and the added advantage of increasing the number of children who may not require hospital admission (Freedman, Parkin, Willan, & Schuh, 2011; Hunter & Seupaul, 2012; Janet, Molina, Marañón, & García-Ros, 2015; Somer, 2015b). However, there are wide variations between the volumes and rates suggested between guidelines and this element of rehydration appears to have the least consistent evidence (Bruzzese et al., 2013; Simpson & Teach, 2011). The National Institute for Health and Care Excellence (NICE) gastroenteritis guideline suggests 50mL/kg over 4 hours and the web resource UpToDate suggests volumes of 50-100mL/kg over 4 hours in its ORT guidance (Freedman, 2015; NICE guidelines, 2009). Similar rates have been published for IV rehydration and thus the BCB suggests rehydration rates of 15ml/kg/hour, increasing to

25ml/hour if there are ongoing losses for both enteral and IV rehydration to create simple regimens (see appendix C and I).

Once dehydration has been corrected, maintenance fluids are required to prevent further dehydration. IV maintenance regimens in children are still largely based on formulae calculated by Holliday and Seger in 1957[3] and whilst their underlying assumptions have since been disputed, the rates they proposed remain the most commonly published given the lack of more contemporary suggestions (Holliday & Seger, 1957). The BCB does not include ongoing IV maintenance regimens as it was felt that these need to be prescribed individually and the BCB was mainly focused on those children who could be discharged. The BCB therefore focusses on the ongoing enteral needs of children which are included in the parent handout (see appendix J). The literature seems to favour early refeeding as studies show that there is no discernible advantage to delayed refeeding and early refeeding is not associated with increased adverse outcomes (Gregorio, Dans, & Silvestre, 2011). Historical practices of diluting feeds have also been refuted by more recent trials (Guarino et al., 2014). Bland diets have also fallen out of favour with critics suggesting that they are less appealing, do not provide adequate nutrition and have not been proven to be effective (Shapiro et al., 2010). Historical formulations of ORS were higher in sugar which was found to actually increase stool volume, which provides the basis for advice to limit high sugar fluids during the child's recovery from gastroenteritis (Goodall, 2014; World Health Organization, 2005) . Eliminating lactose has been found by some studies to reduce the duration of diarrhoea (Dalgic, Sancar, Bayraktar, Pullu, & Hasim, 2011; MacGillivray, Fahey, & McGuire, 2013). However, this is not widely recommended as it was felt that most diarrheal illnesses last for 5 days or less and that the advantages afforded by lactose-free feeds were not sufficient to overcome the inconvenience and possible adverse effects of changing to an alternative feed (Guarino et al., 2014; Johnston, Shamseer, Da Costa, Tsuyuki, & Vohra, 2010; Pieścik-Lech, Shamir, Guarino, & Szajewska, 2013). Finally, there is general agreement that breast feeding should be continued during the rehydration and maintenance phases of recovery but there is scant evidence as to how this should be achieved and whether this is instead of, or as well as ORS (Binder et al., 2014; Ciccarelli et

[3] 100ml/kg for the first 10kg, 50ml/kg for the second 10kg of weight and 25ml/kg for subsequent kg until adult volumes are approached (Holliday & Seger, 1957).

al., 2013; Freedman, 2015; Li et al., 2009). The above suggestions were all used to influence the contents of the parent information sheet that is included in the BCB and provides management advice for parents at home (see appendix J).

The final element of the BCB relates to the promotion of safe discharges, reducing admission rates and preventing revisits. The latter is addressed in information in the parent information sheet about the likely duration of symptoms and the signs and symptoms that warrant returning to the ED. The former two items are prompted by discharge criteria within the pathway document (see appendix C). The criteria reflect standard safe practice in the care of children with gastroenteritis but help to reinforce norm that children should be discharged unless there are reasons not to, which for some clinicians may be a paradigm shift (Chow et al., 2010; Ciccarelli et al., 2013; Freedman, Thull-Freedman, Rumantir, Eltorki, & Schuh, 2014; NICE guidelines, 2009).

In summary, the management of gastroenteritis requires the identification of children with dehydration or severe dehydration; the approach to rehydration must consider the most effective route, volume and type of rehydration fluids. Adjunct therapies may be used to provide symptom relief or terminate the symptoms of disease early. Finally, advice regarding refeeding and the type and volume of feeds are required by whoever will be providing ongoing care of the child as well as who and when to seek additional advice from. The rehydration BCB attempts to address all of these themes. A summary of the themes and BCB interventions are included in table 2 and they will be used to structure the modified systematic review that will follow in the succeeding chapters. It should be noted that other possible interventions, such as anti-diarrhoeal medications are described but none of them are consistently supported in the literature or clinical guidelines. Some of them will be addressed in the discussion section as possible additional interventions to the BCB. The coming chapter will outline the methodology used to search for and retrieve pertinent studies plus how the data was reviewed and evaluated to validate the BCB interventions.

Table 2: Summary of themes and interventions identified in the literature and included in the rehydration BCB

Theme One: Assessment of the degree of dehydration in children with gastroenteritis
Categorical assessment of "no dehydration", "dehydration" or "severe dehydration"
Blood testing only undertaken with initiation of IV fluids not to diagnose dehydration
Theme Two: The route of rehydration in children with gastroenteritis
Oral rehydration promoted
Nasogastric rehydration prompted if oral fails or is unfeasible at 0, 60 and 120 minutes (in rehydration pathway)
Intravenous rehydration only indicated for severe dehydration, large volume ongoing losses and failure of oral rehydration where nasogastric rehydration is unfeasible
Theme Three: The volume of rehydration fluids to be given to children with gastroenteritis?
15mL/kg/hour for 4 hours in rehydration pathway
Increased to 25mL/kg/hour for 4 hours for ongoing losses
Theme Four: The type of fluid used in the rehydration of children with gastroenteritis?
Oral rehydration fluid (low osmolality)
5% Dextrose and 0.9% Sodium Chloride IV fluids
Theme Five: Adjuncts used in the treatment of children with gastroenteritis.
Ondansetron administration for ongoing vomiting
Theme Six: Parental Advice
Restart normal feeds as soon as possible
Continue usual infant feed/breast milk
Avoid high sugar drinks
Offer maintenance fluid plus and replacement fluid for ongoing losses

Chapter Three: Research Methods

Research Aims

A modified systematic review will be undertaken to:

1. Validate the interventions contained within the WDHB Rehydration BCB for the treatment of children with gastroenteritis in the ED.

2. Identify further and/or alternative interventions that could be included in the WDHB Rehydration BCB.

3. To produce a summary of evidence in relation to the BCB interventions.

Data Collection

A systematic approach was taken to search for and retrieve pertinent contemporary evidence. As there are several interventions contained in the BCB, a modified Phenomenon, Intervention, Comparison group and Outcome (PICO) approach was used to generate search terms pertaining to the population (children with gastroenteritis), and the elements from the six themes of treatment listed in Table 2 (see previous page). Searches were executed through Medline, Cinahl, and Scopus (see Appendix K for full search strategy). Reference lists were also reviewed to ensure key texts were included. The resulting evidence was subjected to inclusion and exclusion criteria as listed in Table 3 (Inclusion and exclusion criteria were utilized in an attempt to limit the scope of this investigation, in keeping with a 45 point dissertation).

Table 3: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
▪ Published within 5 years Since June 2009 ▪ Published in English ▪ Published in a peer reviewed publication ▪ Acute community acquired diarrhoea (1-14 days) ▪ Pertains to children between 4 weeks and 18 years of age ▪ Primary research, systematic review or meta-analysis ▪ Sample includes children from developed countries	▪ Published prior to June 2009 ▪ Not published in English ▪ Not published in a peer reviewed publication ▪ Hospital acquired or persistent diarrhoea (>15 days) ▪ Does not pertain to children between 4weeks and 18 years of age ▪ Not primary research systematic review or meta-analysis ▪ Samples *only* includes children from developing countries

Data Analysis

The eventual dataset was comprised of systematic reviews (SR), randomised controlled trials (RCTs), economic evaluations (EE) and cohort studies (CS). Each study was then appraised using modified versions of the Critical Appraisal Skills Programme (CASP) appraisal tools which were chosen because they are reputable and are both concise yet comprehensive (CASP, 2013a; 2013b, 2013c, 2013d, 2013e). Another method that was considered was the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) methodology which is a robust and respected approach. However, it is very complex and it was felt it was unlikely to have been achievable in the available time period for this study as the primary data is necessary for some elements (Guyatt, Oxman, Kunz, et al., 2008; Guyatt, Oxman, Sultan, et al., 2011; Guyatt, Oxman, Vist, et al., 2008; Schünemann et al., 2008). As a compromise, the bias assessment framework from GRADE was incorporated into the appraisal tools as this element was not adequately addressed in the CASP tools (Guyatt, Oxman, Vist, et al., 2011). Appraisal tools for each type of study were devised namely: randomised controlled trials, systematic reviews, cohort studies, diagnostic studies and economic evaluations, an example appraisal tool is included in Appendix L.

The findings from the included studies were organised by theme, then by intervention and finally the results for each outcome measure were collated to enable the collective results to be synthesised. Meta-analysis was considered but was not feasible given that this requires primary data but more importantly because there was insufficient consistency

between the outcomes measures and the methodological approaches taken within the studies. All interventions from the retrieved data were collated in this way and interventions that were not in the BCB were grouped together as additional interventions to meet the second aim of this review. The retrieved data included both diagnostic and therapeutic results. Where possible the same statistical parameters were extracted to allow comparisons between study findings.

For diagnostic studies, likelihood ratios or sensitivity and specificity were compared. They provided useful insights into how accurate a test is for predicting disease. Likelihood ratios can best be described as the probability that a patient who tests positive has the disease compared with one who tests negative; they are often expressed as positive and negative likelihood ratios, where a positive likelihood ratio is:

$$LR+ = \frac{\text{probability of an individual } \textbf{with} \text{ the condition having a } \textbf{positive} \text{ test}}{\text{probability of an individual } \textbf{without} \text{ the condition having a } \textbf{positive} \text{ test}}$$

and a negative likelihood ratio is:

$$LR- = \frac{\text{probability of an individual } \textbf{with} \text{ the condition having a } \textbf{negative} \text{ test}}{\text{probability of an individual } \textbf{without} \text{ the condition having a } \textbf{negative} \text{ test}}$$

(Ebell & Barry, 2008; Lalkhen & McCluskey, 2008).

The relative value of likelihood ratios is quantified as below:

LR	Interpretation
> 10	Large and often conclusive increase in the likelihood of disease
5 - 10	Moderate increase in the likelihood of disease
2 - 5	Small increase in the likelihood of disease
1 - 2	Minimal increase in the likelihood of disease
1	**No change in the likelihood of disease**
0.5 - 1.0	Minimal decrease in the likelihood of disease
0.2 - 0.5	Small decrease in the likelihood of disease
0.1 - 0.2	Moderate decrease in the likelihood of disease
< 0.1	Large and often conclusive decrease in the likelihood of disease

(Ebell & Barry, 2008; Lalkhen & McCluskey, 2008).

The sensitivity of a clinical test refers to the ability of the test to correctly identify those patients with the disease. A test with 100% sensitivity correctly identifies all patients with the disease.

$$\text{Sensitivity} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives}}$$

(Lalkhen & McCluskey, 2008).

The specificity of a clinical test refers to the ability of the test to correctly identify those patients without the disease. Therefore, a test with 100% specificity correctly identifies all patients without the disease.

$$\text{Specificity} = \frac{\text{True negatives}}{\text{True negatives} + \text{False positives}}$$

(Lalkhen & McCluskey, 2008).

Sensitivity and specificity give a numerical value that relates to the accuracy of a test for ruling disease in or out, respectively (Ebell & Barry, 2008; Lalkhen & McCluskey, 2008).

For therapeutic studies, Risk Ratios (RR) will be reported where possible. RRs are a numerical value calculated by dividing the risk of an event in the experimental group by that in the control group (Scott, 2008). A value of greater than 1 denotes an increased risk of an event (either treatment efficacy or adverse risk) and a value of less than 1 denotes that an event was prevented, a value of 1 reflects no effect (Boston University School of Public Health, 2015; Scott, 2008).

Other relevant statistics include K or Kappa value which is a measure of precision (reliability) used to calculate inter-observer agreement for ordinal (categorical) scales. It is a measure of the difference between observed and expected agreement and is quantified as below:

Value	Agreement
<0	less than chance agreement
0.01-0.2	fair agreement
0.41-.60	moderate agreement
0.61-0.80	substantial agreement
0.81-0.99	almost perfect agreement

(Kinlin & Freedman, 2012; Viera & Garrett, 2005).

There are two common correlation coefficients that are used to compare the correlation between two variables, Pearson –product –moment and Spearman. Pearson product-moment correlation coefficient, measures the strength of the linear association between variables denoted by a numerical value between -1 and 1. If the number is near -1 or 1 there is a strong linear correlation between the two variables (positive means as one variable gets bigger the other one does too; negative means that as one variable gets bigger the other gets smaller) and numbers approaching zero show little correlation (*Correlation coefficient*, 2015). Spearman rank correlation is used to test the association between two ranked variables, or one ranked variable and one measurement variable (McDonald, 2014). Spearman rank correlation are similarly valued between 1 and -1 where 1 indicates a perfect association of ranks, zero indicates no association between ranks and -1 indicates a perfect negative association of ranks (*Spearman's rank-order correlation*, 2013).

It had been the original intention to compare the interventions within the WDHB Rehydration BCB against the interventions in the three most commonly used clinical guidelines for paediatric gastroenteritis locally (NICE guidelines, Royal Melbourne's Children's Hospital (RCH) and Starship) (Gavin, 2006; NICE guidelines, 2009; Royal Children's Hospital Melbourne, 2015). However, this was not done for two reasons, firstly, the WDHB Rehydration BCB differs from a guideline in that it includes a collection of resources and the clinical interventions (that may be based on a guideline) are timed and stipulated rather than requiring interpretation or prescription by a clinician. Therefore, it would be difficult to compare it to a guideline. Secondly, after a cursory appraisal of the three guidelines using the AGREE II guideline appraisal tool (Brouwers et al., 2010), it became apparent that two of them would be rated as being of poor quality and would

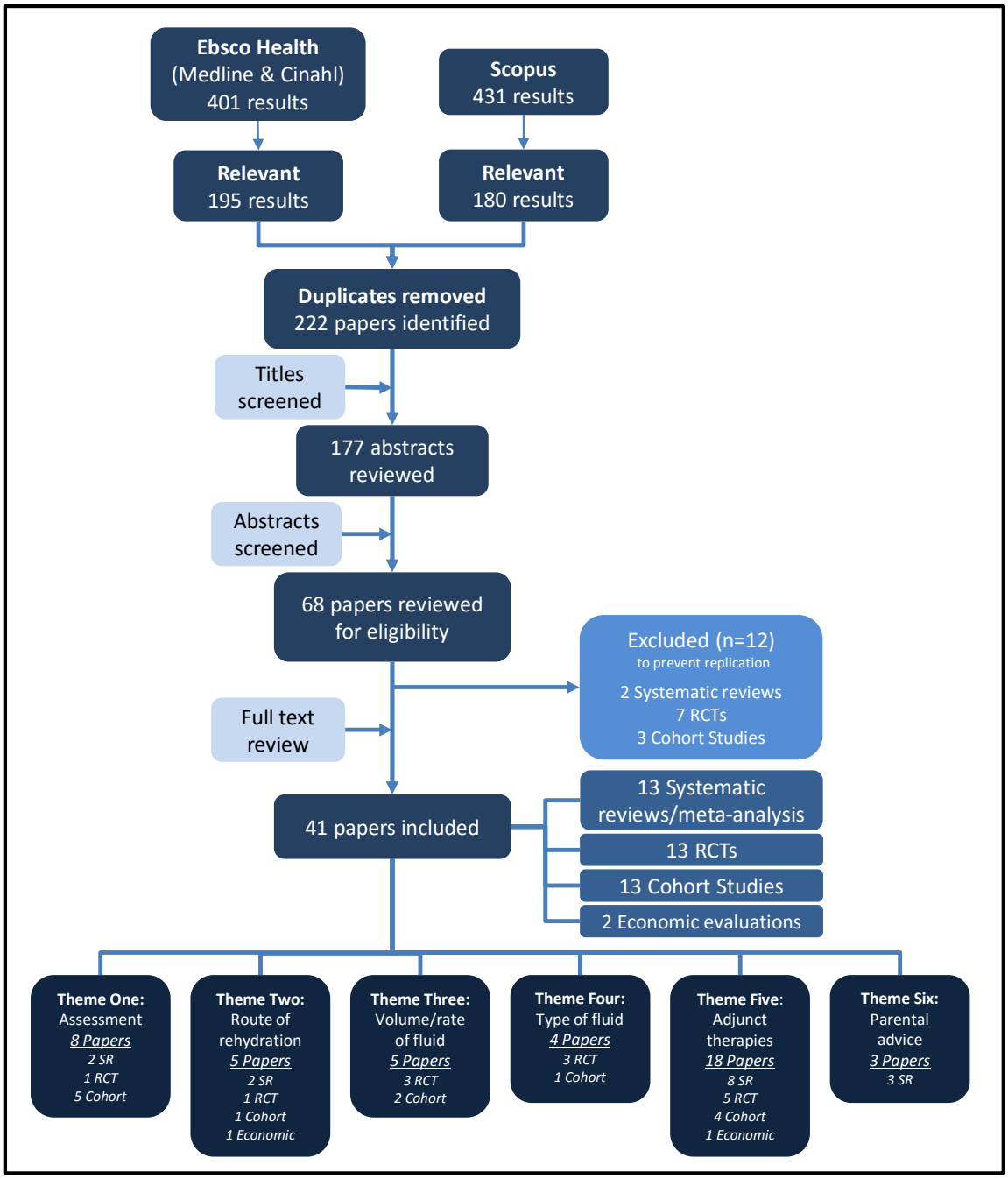
therefore not make credible benchmarks against which to compare interventions. It was decided that published literature would more effectively address the research aims to objectively evaluate the efficacy of interventions for gastroenteritis.

Chapter Four: Findings

Forty one studies were retrieved and appraised including: 13 systematic reviews, 13 RCTs, 13 cohort studies and two economic evaluations (see Figure 2). Where primary studies were included in a systemic review, they were excluded from the data set to prevent duplicate reporting. Two systematic reviews were excluded because an updated review was included that contained identical plus newer studies. The characteristics of the studies included in this review and the results for each of the BCB themes, interventions and associated outcome measures are included in Appendix N (Tables 12-28).

This chapter will present the evidence pertaining to BCB interventions under each theme. In addition, the evidence retrieved for possible additional interventions that could be included in the BCB, will be presented.

Figure 2: Evidence Retrieval Flow Diagram



Theme One: Assessment of the degree of dehydration in children with gastroenteritis

Theme one relates to the assessment of dehydration in children with gastroenteritis and eight studies (SR= 2, RCT=1, CS=5, EE=0) were retrieved with relevant outcome measures and the characteristics are listed in table 12 (page 175). The BCB interventions for the assessment of dehydration are firstly, a categorical tool (Hydration Assessment Tool) to detect "*no*", "*some*" or "*severe*" dehydration using a series of signs and symptoms and secondly, to only undertake blood testing prior to the commencement of IV fluids; when dehydration is assessed as severe or when enteral rehydration has failed or is unfeasible; they are not routinely used to diagnose dehydration. The results of studies that evaluated the diagnosis of dehydration through blood testing were included to ensure that the intervention of not using them is valid. In addition, results of possible alternative interventions that were identified in the data and their predictive values for diagnosing dehydration were also included.

BCB Intervention - Hydration Assessment Tool

The Hydration Assessment Tool (see Figure 1) has not been tested for external validity as this was bespoke and devised for use in the BCB. A few studies did however include individual clinical signs; for instance in their cohort study (n=101), Plaisier et al. (2010), found the only clinical sign that correlated with measured dehydration of >5% (based on post illness weight) was decreased level of consciousness (two tailed Wilcoxon rank-sum test $P<0.05$). They found no correlation for other signs (blood pressure, quality of pulses, heart rate, skin turgor, depth of fontanel, humidity of mucous membranes, depth of eyes, capillary refill time, mental status, urine output, thirst (Plaisier et al., 2010). In their cohort study (n=226), Kinlin and Freedman (2012) found that there was fair inter-observer reliability for the signs of absent tears and sunken eyes (weighted k of 0.32 (95% CI 0.18, 0.46) and 0.40 (95% CI 0.27, 0.51) respectively) but not for general appearance or humidity of mucous membranes (Kinlin & Freedman, 2012). There was otherwise no evidence retrieved that supported or refuted the use of the Hydration Assessment Tool in the BCB or the clinical signs therein (see Table 13).

BCB Intervention – Blood testing not necessary to diagnose dehydration

In terms of laboratory findings, Plaisier et al. (2010) noted a significant correlation between degree of dehydration (by weight loss) and blood urea nitrogen (Spearman r=0.3, p=0.03), base excess (Spearman r=0.31, p=0.03) and serum bicarbonate (Spearman r=0.32, p=0.02), whilst there was no correlation with plasma water (Spearman r=0.21, p=0.98). Levy, Waltzman, Monuteaux, and Bachur (2013), (RCT, n=188) found that there was also a significant correlation between initial point-of-care serum ketone concentration and dehydration (by clinical dehydration score) (Spearman r=0.22, p=0.0 3) and a significant inverse correlation between initial point-of-care serum ketone concentration and serum bicarbonate concentration (Spearman r=-0.26, p<0.001) (Levy, Waltzman, et al., 2013). They also found a significant correlation between serum bicarbonate and dehydration score (Spearman r=0.19, p=0.011) but the ketone and dehydration score correlation was significantly stronger (Wald test =5.51. p=0.019. Serum ketone levels were also compared with general appearance and serum glucose, both had significant inverse correlation (Spearman r= -0.26, p<0.001 and r=-0.74, P<0.001 respectively) and thus decreased as serum ketones increased (Levy, Waltzman, et al., 2013). Whilst correlations are interesting, they are of limited help to clinicians who need ranges or parameters in order to diagnose disease. None of the studies reviewed looked at predictive values for serum ketones or serum bicarbonate and therefore, further work may be needed to create meaningful diagnostic tools (see Table 13).

Additional Interventions Identified to diagnose dehydration

Other methods of assessing hydration were identified in the literature; the Clinical Dehydration Score (CDS) and Gorelick Hydration Scores were found to have moderate accuracy for ruling in dehydration (which varied between studies) but less so for ruling it out (CDS for >6% LR+5.19-11.79; LR- 0.4-0.71; Gorelick >5% LR+1.68-6.26 ; LR- 0.15-0.82) (Falszewska et al., 2014; Freedman, Vandermeer, et al., 2015; Kinlin & Freedman, 2012). The accuracy of the scores increased with increasing severity of dehydration (CDS: <3% dehydration accuracy 47.95-51.61, 3-6% dehydration accuracy 44.75- 48.39, >6% dehydration accuracy 58.41-88.58; Gorelick: >5% dehydration accuracy 57.52-84.56, >10% dehydration accuracy 83.77-86.56). The WHO score was found to be less accurate overall

at detecting >5% dehydration (<80%). Interestingly, for >10% dehydration, unstructured physician assessment had accuracy rates of >80% (although the methods tested for physician assessment varied widely). This suggests that more clinical signs emerge and are recognisable as the severity of dehydration increases (Freedman, Vandermeer, et al., 2015). One study (n=148) did find a correlation between CDS score and length of stay but this was a cohort study and it is not clear whether or not the physicians were blinded to the CDS score which may have influenced their clinical decisions (Bailey et al., 2010). The size, rigor and comparability of the studies was an issue, as was the fact that many studies only included children who were given IVF (suggesting that less severely dehydrated children were excluded from the data) (see Table 14).

Other non-invasive measures included bedside ultrasound (comparing aortic and pulmonary artery ratios) which was found to have moderate sensitivity (0.85 (95%CI 0.68-0.95)) but lower specificity (0.56 (95%CI 0.40-0.72)) and was, consequently, likely to over-diagnose >5% dehydration. Furthermore, it was felt to have limited practical value as the availability of equipment and personnel with the skills to use them may not be readily available and as a result, patient treatment may be delayed in practice (Lei Chen, Hsiao, Langhan, Riera, & Santucci, 2010). Bladder scanning was used to calculate mL/kg/hr of urine production as a marker of hydration and there was a correlation with degree of dehydration ($p<0.0011$) but as two scans are needed this has limited application for the initial diagnosis of dehydration but it could be argued that they may have a potential role in evaluating the efficacy of rehydration regimens (Enright, Beattie, & Taheri, 2010). Urinalysis for specific gravity and ketones was not found to correlate well with dehydration based on post illness weight (diagnostic accuracy for detecting >3% dehydration from urine specific gravity: LR+: 1.07, LR-: 0.9, Sensitivity 0.64 [95% CI 0.49-0.77], Specificity 0.40 [95% CI 0.21-0.61]; diagnostic accuracy for detecting >5% dehydration from urine ketones: LR+: 0.54, LR-: 2.05, Sensitivity 0.38 [95% CI 0.15-0.65], Specificity 0.31 [95% CI 0.19-0.44]).

Perhaps the most promising measure was digital capillary refill time which had high sensitivity (1.00 95% CI 0.75-1.00) for the detection of >5% dehydration (dehydration assessed by post illness weight) (Freedman, Vandermeer, et al., 2015). Specificity was not calculated as there were no false or true negatives in the cohort sample (n=83) (Freedman,

Vandermeer, et al., 2015). Obviously, this requires further work to validate and generate ranges for clinical application.

Finally Pruvost et al. (2013), explored the relationship between theoretical or predicted post illness weight (based on extrapolation on centile chart from previous weights), dehydration score and measured post illness weight. They found that the prevalence of 5% dehydration based on measured post illness weight was 21% (P<0.001) compared with 60% (P<0.001) based on theoretical weight and 66% (p<0.001) based on clinical assessment (Pruvost et al., 2013). They noted that in their cohort, measured post illness weight underestimated the prevalence of >5% dehydration with an average difference of 4%, despite rigorous measurement protocols.

To summarise, this review did not find evidence to support the Hydration Assessment Tool, nor was there sufficient evidence to reliably validate any of the individual clinical signs. The results did show that for severe dehydration, scores based on clinical signs and unstructured physician assessment, were >80% accurate. Reliability decreased for less than severe dehydration.

Theme Two: The route of rehydration in children with gastroenteritis

Theme two relates to the route of rehydration fluids and six papers (SR= 2, RCT=2, CS=1 EE=1) were retrieved with pertinent outcome measures and these are listed in table 15. The BCB promotes oral rehydration; NG rehydration is prompted if oral fails or is unfeasible at 0 and 60 minutes (in rehydration pathway). IVF are indicated only if the degree of dehydration is felt to be severe or the enteral routes have failed or are not feasible.

BCB intervention - Enteral (oral/NG) versus IV rehydration

Several studies compared outcome measures for enteral versus IV rehydration and multiple studies have found no statistical difference between them in terms of the duration of diarrhoea, weight gain, total fluid intake or risk of hypo/hypernatraemia (see Table 16) (Dalby-Payne & Elliott, 2011; Hartling et al., 2009). There may be some reduction in length of stay with enteral rehydration but the effect size varies across studies

(Dalby-Payne & Elliott, 2011; Hartling et al., 2009). There is an increased risk of phlebitis (RD -2%, [95% CI -4 to -1]) with IVF and an increased risk of paralytic ileus (RD 3%, [95%CI 1 to 5]) with enteral rehydration and one RCT found an increase in the risk of seizure or deaths with IVF (RR 0.36 [95% CI 0.14 to 0.89]) (Dalby-Payne & Elliott, 2011; Hartling et al., 2009). Freedman et al. (2013) found that IVF were associated with higher revisit rates independent of disease severity (Freedman, Thull-Freedman, et al., 2013). These results would seem to favour oral/NG rehydration as they have similar efficacy with fewer risks.

Additional Interventions relating to the route of rehydration

Two studies evaluated the use of subcutaneous (SC) fluid administration (augmented by the SC administration of recombinant human hyaluronidase). One RCT (n=148) found that recombinant human hyaluronidase facilitated subcutaneous fluid (rHFSC) administration was not inferior to IVF in children with mild to moderate dehydration for the following outcome measures: mean total volume infused (in ED), weight increase post infusion and improvement in dehydration score (Spandorfer et al., 2012). RHFSC was inferior to IVF for total volume infused when the inpatient area was included but this was likely due to the fact that the ward area had received no training in the use of SC fluids and swapped children over to IVF. In terms of treatment failure there was a higher proportion in the IVF group (treatment failure rHFSC 7% versus IVF 24%) which was almost exclusively due to catheter placement success rates being higher in the SC group (catheter placement: rHFSC 100%, IV 78.7%, $P < 0.0001$) and occurred only in the under 3 years of age subgroup. Furthermore, there was increased satisfaction from practitioners and parents for SC fluids compared with IVF (practitioners rated administration as “easy” for rHFSC 95.5% versus IV 65.3% ($P < 0.001$); proportion of parents rated “satisfied” or “very satisfied” was rHFSC 94.5% versus IV 73.3%). In terms of pain during catheter placement and at the end of the infusion, there was little difference between the groups but there were more site related events such as erythema and swelling in the rHFSC group; all of which were described as mild to moderate and resolved without treatment (Mace et al., 2013; Spandorfer et al., 2012). Furthermore, an economic evaluation by Mace et al. (2013) found that SC fluid administration was cheaper than IVF administration (rHFSC fluids US$722, IVF US$889)

which again was due to reduced time placing the catheter and was most marked in the under 3 age group (Mace et al., 2013).

To summarise the findings for theme two, enteral rehydration appears to be as effective as IV rehydration with fewer associated adverse events and reduced hospital length of stay and revisits. Subcutaneous fluid administration was not found to be inferior to IV rehydration and was associated with fewer treatment failures in the 1-3 age group. The next section will focus on how much fluid should be administered and how fast.

Theme Three: The volume/rate of rehydration for children with gastroenteritis

Theme three relates to the volume/rate of rehydration and five studies (SR= 0, RCT=3, CS=2, EE=0) were retrieved with outcome measures that were relevant to this theme (see Table 18). Within the BCB, children with signs of dehydration (but not severe dehydration) are given rehydration fluids at a rate of 15mL/kg/hr for 4 hours. If tolerated, this is given orally, if not by NGT and if this fails (usually due to ongoing vomiting) or if an NGT is unfeasible this is given IV. If losses are ongoing, the rate is increased to 25mL/kg/hr regardless of route for up to 4 hours (with hourly assessments). If after 4 hours, the child is still deemed to be dehydrated, a bespoke fluid regimen is prescribed. All children with no signs of dehydration initially are given a fluid challenge to ensure they are able to tolerate oral fluids and are then discharged (provided discharge criteria are met).

BCB intervention – 15mL/kg/hour for up to 4 hours rapid rehydration

The closest regimen to the BCB's 15mL/kg/hr for up to 4 hours was described in Nager and Wang's (2010) study (n= 88) which compared the efficacy and safety of 50mL/kg of IV rehydration over 1 hour versus 3 hours. They found there was no significant difference between weight gain, heart rate decrease or revisits, they conclude that ultra-rapid rehydration seems both safe and effective (Nager & Wang, 2010). However, there were several methodological and reporting issues which introduced significant bias. For instance, children who were admitted to hospital were excluded from the analysis, the outcome measures were poorly defined and it is not clear how the post discharge weight was obtained (which could reflect a measurement error). Furthermore, children with a dehydration level of moderate were enrolled (based on a clinical dehydration score) but

the actual weight gain suggested many were only mildly dehydrated (<5%) or were inadequately rehydrated for their post treatment weight and there were no pre and post dehydration comparisons based on the score which might have explained this inconsistency. It was noted that rapid rehydration over one hour was associated with worsening metabolic acidosis (most likely due to chloride administration) but it is unclear what the clinical significance of this is. Thus this study cannot be said to either endorse or refute the BCB IV rehydration rate of 15mL/kg/hour for up to 4 hours.

BCB intervention – 25mL/kg/hour for up to 4 hours rapid rehydration

Powell et al. (2011), compared NG rehydration (n= 228) at 100mL/kg over 4 hours (25mL/kg/hr) called rapid rehydration rate (RHR) with standard rehydration rate (SRR) based on estimated fluid deficit (5-7%) administered over 24 hours (Powell, Priestley, Young, & Heine, 2011). They found no statistically significant difference between the two regimens in terms of >2% weight loss, inability to tolerate the insertion of a nasogastric tube, frequent or persistent vomiting or IVF requirement. Secondary treatment failure rate was slightly higher (2.6%) in the RHR rehydration group but due to insufficient numbers, the confidence intervals were wide and this difference was not found to be significant (P=0.52). RHR was successful for 70% of patients, whereas 30% either were not discharged from the ED or were readmitted to the hospital within 24 hours. Given that all SRR patients were admitted, this is still likely to be associated with significant cost savings. Only 5.9% of RHR-treated patients required IVF resuscitation and the number of children with moderate signs of dehydration at 4-6 hours was lower in the RHR group (rapid 11.8% versus slow 22.9%, no P value was calculated) suggesting that the RHR was at least as effective as the SRR regimen. Limitations for this study were that it was obviously not blinded and thus decisions by treating clinicians may have skewed outcomes. Nevertheless, in this study rapid NG rehydration over 4 hours at a rate of 25mL/kg/hour was found to be safe and effective.

Additional Interventions – alternative regimens found

Freedman, Parkin, et al. (2011), tested the efficacy of rapid (60 mL/kg) versus standard (20 mL/kg) IV rehydration with 0.9% saline over an hour, in children (n=226) who had failed oral rehydration and had moderate dehydration; subsequent fluids were administered at maintenance rates (Freedman, Parkin, et al., 2011). There was no evidence of a difference between the rapid and standard rehydration groups in the proportions of participants who were rehydrated at two hours (41/114 (36%) versus 33/112 (30%) respectively; difference 6.5% [95% CI −5.7% to 18.7%]; P=0.32). Lack of significant difference persisted even after adjusting for weight, baseline dehydration score, and baseline pH. There was no statistical difference between the rates of prolonged treatment (52% rapid *v* 43% standard; difference 8.9%, [95% CI 21% to −5%]; P=0.19). The only statistically significant difference between the two groups was median time to discharge (rapid 6.3 versus standard 5.0 hours; P=0.03). The authors concluded that there were no relevant clinical benefits from the administration of rapid rather than standard intravenous rehydration to haemodynamically stable children requiring intravenous rehydration. Some points of interest are that children who failed oral rehydration do not appear to have been offered NG fluids, which seems at odds with current best practice and one could argue that some of these patients may not in fact have "needed" IVF and also that in this study, the two groups are receiving different overall volumes and not just rates which may not be a fair comparison.

Janet et al. (2015), (n=83) observed the effects of administering 2 hours of 20mL/kg IV rehydration with NS & 2.5% Dextrose to a cohort of children and found statistically significance improvements in dehydration markers such as serum ketone levels (before 1.5 Mmol/L (IQR 0.6–4.0); after 0.8 Mmol/L (IQR 0.2–2.8); P <0.001), serum urea level (before 34.4 Mg/dL (IQR 31.3–37.4); after 27.3 Mg/dL (IQR 23.6–31); P <0.001) and Gorelick dehydration score (before 3 (2–4); after 0 (0–1), P <0.001) (Janet et al., 2015). There was no control group so it is not possible to compare this with no treatment or to draw comparisons between this and alternative fluids or volume regimens.

The BCB includes mandated interventions and is similar to a clinical pathway but has yet to evaluated empirically. Waddell et al. (2014) explored the impact of their gastroenteritis

clinical pathway on patient outcomes. The exact details of the pathway were not described other than to say that rapid enteral rehydration was promoted over 4 hours and thus it is difficult to ascertain whether it is or is not comparable to the BCB. They reported that the number of children who received oral and NG fluids had increased post pathway but not significantly. Paradoxically they found that ED LOS actually increased, although this may be at least partly attributable to increased patient volumes between the two audit periods or the higher triage scores of the post intervention group (Waddell, McGrath, & Maude, 2014). Comparative admission rates were not reported which seems an omission given that longer ED LOS may have been acceptable if overall admission rates were lower.

In summary, rehydration volumes of 15mL/kg/hour for four hours were not effectively evaluated in the studies reviewed for enteral or IV fluids. Whereas, IV and enteral rehydration volumes of 25mL/kg/hour for four hours was found to have similar efficacy with reduced admission costs for NG rehydration. Other regimens were evaluated but no superior volume or rate emerged from the data.

Theme Four: The type of fluid used in the rehydration of children with gastroenteritis

Theme four relates to the type of rehydration used and four relevant studies (SR= 0, RCT=3, CS=1, EE=0) were retrieved (see Table 21). In terms of BCB interventions, the fluids used are: a low osmolality oral rehydration solution (Pedialyte Bubble Gum® flavour) for enteral rehydration and 0.9% Sodium Chloride plus 5% Dextrose for IV hydration, the pertinent results for these will be addressed in turn below.

BCB intervention – Low osmolality ORT

No studies in this review measured the efficacy of Pedialyte®; two studies compared the efficacy and palatability of other ORS solutions and these will be presented in the additional interventions section (Passariello et al., 2015; Passariello et al., 2011).

BCB Intervention - 0.9% Sodium Chloride plus 5% Dextrose IV fluid

One RCT conducted by Levy, Bachur, Monuteaux, and Waltzman (2013), compared the efficacy of NS versus 0.9% NSD5 when given to dehydrated children with gastroenteritis (n=188) as a 20mL/kg bolus over an hour (Levy, Bachur, et al., 2013). They found that the addition of 5% Dextrose reduced the serum ketone level more so than for NS alone (at 1 hour mean difference was 1.1mmol/L [95% CI 0.4 to 1.9 mmol/L] and at 2 hours mean difference was 1.6mmol/L [95% CI 0.9 to 2.3 mmol/L]). There were also modest decreases in admission rate (risk difference 9%; 95% CI -5% to 22%) and revisit rate (risk difference 7%; 95% CI -9% to 23%) in the NSD5 group. However, the volumes given were low in comparison with other rehydration regimens and it was unclear whether this actually corrected the dehydration in the sample. Nevertheless, the study did literally measure the impact of one bolus of 20mL/kg of two different fluids and based on these results it would seem that the addition of Dextrose helps correct the ketoacidosis that is associated with dehydration in gastroenteritis.

Further support for using an isotonic sodium concentration solution for IV rehydration may be found from Hanna and Seberi's (2010), cohort study (n=141). They compared serum sodium levels before and after receiving up to 24 hours of hypotonic IV maintenance fluid (mostly 0.3% NaCl) for gastroenteritis (after receiving isotonic boluses to correct shock) (Hanna & Saberi, 2010). Of the 97 children who started with isonatraemia (Serum Na 135-145), 18 (18.5%) developed hyponatraemia and whilst this did not achieve statistical significance ($P<0.34$) it does have clinical significance in that it appears to reinforce the previously mentioned concerns regarding the link between hypotonic IV maintenance fluids and iatrogenic hyponatraemia. In this study, no comparison was made with isotonic IV fluids so there was no corroboration that these do not cause similar drops in serum sodium levels. Levy, Bachur, et al.'s (2013) study might have provided indirect support for this but they did not measure serum sodium as an outcome measure. Hence, of the two studies pertaining to the BCB IV rehydration solution, one supported the addition of 5% Dextrose whereas the other only indirectly supports the sodium content by questioning the safety of hypotonic IV solutions. Considering enteral solutions, as stated earlier, no

studies included Pedialyte®, the BCB enteral rehydration fluid but two studies looked at the efficacy of other ORS preparations and these will be described below.

Additional Interventions

The first study (RCT; n=119) was conducted by Passariello et al. (2011) who found that a solution of super ORS containing zinc and prebiotics significantly increased the proportion of children with resolution of diarrhoea at 72 hours when compared with standard ORS in a sample of children with gastroenteritis (Standard ORS 50% versus Super ORS 72.9%; P = 0.01) (Passariello et al., 2011). Their findings were also favourable for super ORS compared with standard ORS in terms of stool frequency (see Table 23), parental absenteeism (number of missed working days: standard ORS 1.45; [95% CI, 1.02-1.88] versus super ORS 0.39; [95% CI, 0.08-0.70]; P < 0.001) and total consumption of ORS (standard ORS 22mL/kg; [95% CI 17-29] versus super ORS 50 mL/Kg; [95% CI, 41-59]). They conclude that the zinc and prebiotics have a favourable effect on the gut and thus diarrhoea is abated sooner. Obviously it is unclear whether the effect is due to prebiotics, zinc or some other feature of the super ORS, or whether the improved consumption increased the effect but it does suggest that the super ORS was more palatable. However, support for the efficacy of zinc in reducing diarrhoea duration comes from another study by Passariello et al. (2015) and zinc will also be discussed further in theme five.

In this second RCT (n=83) they found that a vanilla pudding type ORS gel solution that also contained zinc was better tolerated than their standard ORS as demonstrated by the increased consumption (at 4 hours: Standard ORS 8mL/kg versus ORS Gel plus zinc 19mL/kg [P<0.001]; at 24 hours: standard ORS 11mL/kg versus ORS Gel plus zinc 30mL/kg [P<0.001] and the proportion of children who failed to drink 10/mL/kg/day ORS due to refusal was lower in the ORS Gel plus zinc group (Standard ORS 30% versus ORS Gel plus zinc 2.3% [P=0.001]) (Passariello et al., 2015). Furthermore, the addition of zinc reduced both the mean duration of diarrhoea (Standard ORS 116.0 ± 40.7 hrs versus ORS Gel plus zinc 93.2 ± 38.8 hrs [P =0.001]) and the proportion of children who had diarrhoea at 72 hours (Standard ORS 72.5% versus ORS Gel plus zinc 48.8% [P= 0.028]) (Passariello et al., 2015). This suggests that different formulations may increase the success rate of ORT due to increased palatability and reinforces previous findings that zinc has a beneficial effect

on the duration of diarrhoea. The vanilla gel had 25% less sodium than its comparison so this may have increased its appeal.

To summarise, the use of isotonic IV Sodium Chloride was indirectly supported based on findings that hypotonic fluid can induce hyponatraemia. The addition of 5% glucose was supported as it was found to lower serum ketone levels faster. No studies evaluated the efficacy of the BCB low osmolality ORS but there was support for the assertion that palatability has an impact of ORT success rates and that the addition of zinc and/or prebiotic may reduce the duration of diarrhoea.

Theme Five: Adjuncts used in the treatment of children with gastroenteritis

Theme five includes adjunct therapies used in the management of gastroenteritis in children and 18 studies (SR= 8, RCT=5, CS=4, EE=1) were included in this theme (see Table 24 for characteristics). The BCB intervention for this theme involves the use of Ondansetron (anti-emetic) to reduce the duration and frequency of vomiting and thus increase the success of ORT.

BCB Intervention - Ondansetron

Several studies evaluated the efficacy of Ondansetron at terminating vomiting and increasing the success of ORT. B. Carter and Fedorowicz (2012) undertook a systematic review (10 Studies, 1049 Participants) on the efficacy of anti-emetics in the treatment of gastroenteritis and found that oral Ondansetron increased the risk of cessation of vomiting (RR = 1.33 [95% CI 1.19-1.49] p<0.001; 12 =0%) and the odds of cessation of vomiting were over four times more likely with Ondansetron versus placebo (OR of 4.33 [95% CI 2.11 to 10.11] p<0.01) (B. Carter & Fedorowicz, 2012). Dalby-Payne & Elliot (2011) found in their systematic review (5 RCTs for this outcome, n=649), that significantly fewer patients had vomiting 24 hours after administration of Ondansetron when compared with placebo (Dalby-Payne & Elliott, 2011). This finding was endorsed by Freedman, Hall, et al. (2014) who also found in their RCT (n=215) that Ondansetron reduced the number of children with vomiting at 24 hours (RR=0.40 [95% CI 0.26 to 0.61], NNT=5) (Freedman, Hall, et al., 2014). Both Dalby-Payne & Elliott (2011) and Freedman, Hall, et al. (2014),

found that Ondansetron decreased the mean number of vomiting episodes in the first 24 hours (Freedman et al.: RR= 0.30 [95% CI 0.18 to 0.50]).

Several studies found that Ondansetron reduced the risks of IV fluid requirement (RR ranges 0.31- 0.57, NNT ranges 4 -13) and admission rates albeit with varying magnitudes of effect between studies (RR ranges 0.22-0.8) (see Table 25) (B. Carter & Fedorowicz, 2012; Dalby-Payne & Elliott, 2011; Freedman, Hall, et al., 2014; Hervás et al., 2012). One retrospective cohort review found that a higher proportion of children revisiting had received Ondansetron on their index visit but that the overall number of admissions was still lower in the Ondansetron group versus placebo (5.3% compared with 7.3%) (Sturm, Hirsh, Schweickert, Massey, & Simon, 2010). This study had some reporting bias issues, so the significance of this result is somewhat unclear. Hervás et al. (2012) found in their cohort study (n=1871), that whilst there were no differences in the medical costs between the Ondansetron and non-Ondansetron groups in the ED (US $22,078 vs US $21,987, respectively), there were significant cost savings in overall hospitalization costs (US $9600 for the Ondansetron group and US $25,079 for the non-Ondansetron group, providing a 73.7% saving associated with Ondansetron use) (Hervás et al., 2012). They reported no statistical difference in LOS with Ondansetron in their cohort (Hervás et al., 2012). However, it should be noted that there were significant methodological flaws with this study as there was no blinding and patients were not randomly assigned to treatment/placebo groups. This raises concerns about the relative acuity and comparability of the two groups and thus these results should be treated cautiously. Nevertheless, it does illustrate that the costs of treatment appear to be significantly increased when associated with a hospital admission. Three articles reported on the outcome of revisit rate and two found no significant difference between the Ondansetron and placebo groups and one found that more children who were given Ondansetron were likely to return (B. Carter & Fedorowicz, 2012; Hervás et al., 2012; Sturm et al., 2010). However, the latter was the above mentioned cohort study with methodological issues whereas one of the former was a systematic review including over a thousand participants and thus its results should perhaps be given more credence.

Freedman, Powell, et al. (2010) compared the efficacy of Ondansetron at different dosages. The oral formulation is a 4mg dispersible wafer and thus can only practically be given at doses of 2, 4 or 8mg (half, one or two wafers) the dosage given by weight ranges and which in their study were 2 mg for children weighing 8–15 kg, 4 mg for children weighing more than 15 kg and up to 30 kg, and 8 mg for children weighing more than 30 kg (Freedman, Powell, Nava-Ocampo, & Finkelstein, 2010). Given that this results in a variation of dose based on mg/kg, they explored whether a larger effect was seen in children receiving a larger dose by weight. They found no statistical correlation for dosage ranges between 0.13mg/kg and 0.26mg/kg in terms of: volume of ORT consumed, weight gain, cessation of vomiting, frequency of diarrheal episodes (per hour) or ED LOS. There was also no discernible difference in dosage between those children who vomited or did not, those that required IVF or did not and those that were hospitalised and those that were not (Freedman, Powell, et al., 2010). Ondansetron administration was associated with one adverse effect; two papers reported an increase in the episodes of diarrhoea following Ondansetron administration versus placebo (Dalby-Payne & Elliott, 2011; Freedman, Hall, et al., 2014). Clearly this could be seen to negatively impact on both admission rates and/or revisit rates but no one appeared to explore this explicitly. The fact that Ondansetron is associated with lower admission rates and a neutral effect on revisit rates seems to suggest that this adverse effect does not significantly detract from Ondansetron's performance overall.

Overall Ondansetron has been found to lead to cessation of vomiting, reduced mean number of vomiting episodes, reduced risk of IVF use, reduced risk of admission and therefore reduced costs. These findings are partially supported by Freedman et al.'s, (2012) time series analysis findings that as Ondansetron use has increased over time in one Canadian tertiary ED, the need for IVF has decreased as has mean LOS and revisit rate (Freedman, Tung, Cho, Rumantir, & Chan, 2012). Other adjunct therapies were identified in the review and these are presented below.

Additional adjunct therapies identified - Dimenhydrinate

One RCT conducted by Gouin et al. (2012), compared the efficacy of Dimenhydrinate (an anti-emetic) versus placebo (n=144). They found no statistical differences between the

groups in terms of treatment failure (i.e. vomited >1 time post treatment); 31% in the Dimenhydrinate group, compared with 29% in the placebo group (difference: 0.02 [95% confidence interval: –0.12 to 0.17]) (Gouin, Vo, Roy, Lebel, & Gravel, 2012). They also found no differences between the two groups in terms of IV fluid requirement, mean number of vomiting or diarrhoea episodes, abdominal pain, nausea, duration of symptoms, adverse events, revisit or parental absenteeism (Gouin et al., 2012). Thus, this study did not support the use of dimenhydrinate in children with gastroenteritis.

Additional adjunct therapies identified - Granisetron

One systematic review evaluated the efficacy of Granisetron (an anti-emetic) (B. Carter & Fedorowicz, 2012). They found that versus placebo it was effective for the outcome of cessation of vomiting (OR of 3.25 [95% CI 0.62 to 17.69], $p<0.05$), although it was unclear how many studies were included and there were wide confidence intervals. When compared with Ondansetron, the findings suggested that Ondansetron was superior in efficacy (estimated best treatment option: Ondansetron 65%, Granisetron 35% and placebo 0%) (B. Carter & Fedorowicz, 2012).

Additional adjunct therapies identified - Domperidone

One RCT (n=56) compared domperidone plus ORT with ORT alone and found no difference in vomiting overall and the only time a decreased incidence of vomiting reached statistical significance was at 48-72 hours (see Table 26) (Kita et al., 2015). However, this study was considerably underpowered and there were numerous methodical concerns relating to blinding, patient selection and attrition and thus the results should be treated with caution.

Additional adjunct therapies identified - Racecadotril

One systematic review conducted by Lehert et al. (2011), compared the efficacy of Racecadotril (an anti-secretory anti diarrhoeal agent) versus placebo (9 RCTS, 1384 children) in children with gastroenteritis. They found that Racecadotril reduced the mean duration of diarrhoea by one day (Racecadotril 1.75 days versus placebo 2.81 days) and children administered Racecadotril were twice as likely to recover at any point during the periods studied when compared with controls (Hazard Ratio HR = 2.04, [95% CI 1.85; 2.32]

P < 0.001.) Both inpatient and outpatient studies found that mean stool output was consistently decreased with Racecadotril administration (mean stool output ratio: inpatient studies - 0.59 (0.51; 0.74), P < 0.001. I2 = 31; mean ratio of number of diarrhoeic stools - outpatient studies, 0.63 [95% CI0.47 to 0.85], P < 0.001, I2 = 0.26) (Lehert et al., 2011). Furthermore, Rautenberg et al. (2012) undertook an economic evaluation based on the UK health setting and predicted that Racecadotril administration in conjunction with ORT would result in a cost saving of -£379 ($924 NZD) per encounter compared with ORT alone and based on reductions in primary care revisits and secondary referrals (Rautenberg, Zerwes, Foerster, & Aultman, 2012). They also predicted that quality-adjusted life years (QALYs) would increase by 0.0008 years with Racecadotril.

Additional adjunct therapies identified - Loperamide

Loperamide (a synthetic opioid) was reported in one SR and was associated with a mean reduction in duration of diarrhoea of 0.8 days [95% CI 0.7 to 0.9] in one study (Dalby-Payne & Elliott, 2011). However, it was associated with an Absolute Risk Increase of 8.6% [95% CI 6.4% to 10.9%] for adverse events and 0.8% [95% CI –0.1% to +1.8%] for serious adverse effects (defined as ileus, lethargy, or death) in one study (Dalby-Payne & Elliott, 2011).

Additional adjunct therapies identified - Zinc

Duration of diarrhoea was reported from 2 SRs in one review SR. For duration of diarrhoea, the weighted mean difference in days were –0.69 P <0.0001 [95% CI –0.97 to –0.40] for the first SR (RCT 13, n=5643) and –12.27 P =0.025 [95% CI –23.02 to –1.52] for the second SR (RCT 9, n=2741) for zinc versus placebo (Dalby-Payne & Elliott, 2011). In terms of total stool volume one study (RCT 13, n=5643) reported a standardised mean difference of –0.38 [95% CI –1.04 to +0.27] for zinc versus placebo (Dalby-Payne & Elliott, 2011). Whilst zinc may improve the duration and volume of diarrhoea it was associated with an increased risk of vomiting in 2 SRs. One (RCT 5, n=3156) reported a RR of 1.22 [95% CI 1.05 to 1.43] and the second (RCT 8, n=4727)RR 1.71 P <0.0004 [95% CI 1.27 to 2.30] (Dalby-Payne & Elliott, 2011).

Additional adjunct therapies identified - Probiotics

There were a large number of trials that explored the efficacy of probiotics at reducing the duration of diarrhoea in children with gastroenteritis. Most of these trials were of low or very low quality and there were considerable discrepancies between them in terms of methodology, definitions of diarrhoea that were used, gaps in reported findings as well as their setting and context. Furthermore, several of the systematic reviews collated results for different strains of probiotic making it impossible to identify the most effective strains. Despite these issues, the results consistently showed that probiotics reduced the duration of diarrhoea by approximately 1 day, although there was considerable variation in the magnitude of effect between studies, which is likely due to the heterogeneity between studies. (Allen, Martinez, Gregorio, & Dans, 2010; Dinleyici, Eren, Ozen, Yargic, & Vandenplas, 2012; Freedman, Sherman, et al., 2015; Pieścik-Lech, Urbańska, & Szajewska, 2013; Szajewska, Ruszczyński, & Kolaček, 2014; Szajewska, Skórka, Ruszczyński, & Gieruszczak-Białek, 2013; Szajewska, Urbańska, Chmielewska, Weizman, & Shamir, 2014). Furthermore, all but one study which reported this outcome measure, found there was a significantly lower risk of having diarrhoea, 3 days after probiotic treatment (Dalby-Payne & Elliott, 2011; Dinleyici et al., 2012; Szajewska et al., 2013). A few studies also showed a reduction in hospitalisation duration of approximately 1 day (Dalby-Payne & Elliott, 2011; Dinleyici et al., 2012). No studies reported any adverse effects with the use of probiotics.

The most frequently tested probiotics were Lactobacillus GG, Lactobacillus reuteri, Lactobacillus reuteri DSM 17938, Lactobacillus acidophilus LB and Saccharomyces boulardii. One systematic review found that the largest effect was seen in European studies and at doses ≥1010 CFU/day (Szajewska et al., 2013). Regardless of the poor quality of studies, the sheer number of trials with similar results cannot be overlooked and thus it would seem that probiotics may reduce the duration of diarrhoea. However, further work is needed to identify the most effective strains and the preparations/formulations that are effective.

To summarise, Ondansetron use was associated with cessation of vomiting, reduced need for IVF and admission and thus overall hospital costs. Other anti-emetic agents: Dimenhydrinate, Granisetron and Domperidone were not found to have a statistically

significant impact on treatment failure in children with gastroenteritis. Racecadotril (an anti-secretory agent) was found to reduce the duration of diarrhoea by one day and this was associated with reduced costs in one economic evaluation. Loperamide (an anti-diarrhoeal agent) was associated with significant adverse outcomes including death in a small number of children. Zinc was shown to reduce both the volume and duration of diarrhoea but may increase the risk of vomiting. Several studies reported a decrease in the duration of diarrhoea of approximately one day following the use of probiotics but the strains and dosage used between studies was variable with Lactobacillus GG and Saccharomyces boulardii emerging as the strains with the most consistently reported efficacy.

Theme Six: Parental advice (type and volume of fluid to administer at home)

Theme six relates to the advice given to parents for the ongoing care of their children at home and four studies (SR= 3, RCT=0, CS=0, EE=0) were included with pertinent outcome measures (see Table 27). The BCB interventions for this theme are to re-establish normal feeds as soon as possible, to continue offering usual milk feeds, to avoid high sugar fluids and foods and to aim for usual maintenance fluid intake plus replacement for ongoing losses.

BCB intervention – Early refeeding

Gregorio et al. (2011) conducted a systematic review comparing early versus delayed refeeding post gastroenteritis. This included 12 RCTs (1226 participants) and concluded that there is little additional risk in terms of unscheduled use of IV fluids, persistent diarrhoea, vomiting or longer hospital stays for children who were re-fed early. For the outcomes relating to duration of diarrhoea, there was a small effect favouring early refeeding but this was not significant and associated with significant heterogeneity ($P=0.11$, $I^2 = 82\%$). The outcomes relating to stool volume and weight gain were similarly not significant (Gregorio et al., 2011). This suggests that there is no advantage to delaying refeeding and no apparent harm in refeeding early.

BCB intervention – Continue usual milk feeds

No studies in this reviewed addressed dietary restrictions or diluting feeds specifically; the use of lactose free feeds will be discussed under additional interventions.

BCB intervention – Avoid high sugar feeds

No studies in this reviewed addressed this aspect of management.

BCB intervention – Continue breastfeeding throughout rehydration and maintenance phases of treatment.

No studies in this reviewed addressed this aspect of management.

BCB intervention – Usual fluid intake plus replacement for ongoing losses

No studies in this reviewed addressed this aspect of management.

Additional Interventions

Two SRs reported results from multiple studies (see Table 29) comparing the efficacy of lactose versus lactose-free feeds. MacGillvray et al. (2013) found that lactose-free products may reduce the duration of diarrhoea by an average of about 18 hours (MD -17.77, 95% CI -25.32 to -10.21, 16 trials, 1467 participants, low quality evidence). Lactose free products may also reduce the risk of treatment failure (defined variously as continued or worsening diarrhoea or vomiting, the need for additional rehydration therapy, or continuing weight loss) by about one half (RR 0.52, 95%CI 0.39 - 0.68, 18 trials, 1470 participants, moderate quality evidence) (MacGillivray et al., 2013). Dalby-Payne and Elliott (2012) also found that lactose-free feeds may be more effective at reducing the duration of diarrhoea in children with mild to severe dehydration but there was significant variation in the degree of effect (see Table 29). From their analysis of 5 studies the evidence is unclear whether lactose-free feeds are more effective at improving weight gain but they report that lactose free feeds may be more effective at reducing total stool volume (RCT 1, n=200) mean total stool volume for Lactose: 164 mL/kg versus Lactose free 69mL/kg ($p<0.001$) (Dalby-Payne & Elliott, 2011).

To summarise the results from this review, in relation to parental management of gastroenteritis there appears to be neither any disadvantage for re-feeding early nor any advantage to delaying refeeding. Lactose free feeds may reduce the volume and duration of diarrhoea

Chapter Five: Discussion

This chapter will discuss the review findings in the context of the wider evidence to gauge their significance and to draw comparisons with previous consensus on the management of gastroenteritis. Linking back to the aims of this study, this discussion will evaluate and validate the BCB interventions and enable possible alternative or additional interventions to be explored. A summation of the findings and discussion will be presented (see Table 4) which will be included in the BCB package to augment the promotion of the BCB. The following discussion will culminate in the synthesis of implications for practice and areas that require further research.

Theme One: Assessment of the degree of dehydration in children with gastroenteritis

The results of this review confirm that individual clinical signs have not been found to consistently correlate with the exact degree of dehydration. Combinations of signs in hydration scores did increase accuracy but they only achieved >80% accuracy for severe dehydration. The results also highlight that variations in the benchmarks used to evaluate diagnostic tests makes it difficult to compare tests or pool results. Studies using dehydration scores as the benchmark must therefore be treated with trepidation as their accuracy has not been consistently demonstrated, especially for mild to moderate dehydration. Pruvost et al. (2013) also highlighted that using post illness weight is not necessarily accurate; they found measured post illness weights were lower than predicted weights and correlated better with clinical diagnosis of dehydration. This has significant implications given that many diagnostic tests are evaluated by percentage dehydration ascertained by post illness weight. One suggested explanation for this is that the post illness weights may reflect a loss of lean body mass (catabolism), resulting from reduced diet, increased intestinal losses and increased nutritional requirements for intestinal regeneration during the illness (Powell et al., 2011; Pruvost et al., 2013). Pruvost et al.'s (2013) findings, however, were dissimilar to an earlier study by Steiner et al. (2007); they reported good correlation between theoretical and post illness weight although this was a small study (n= 79) and the methods for obtaining the post illness weights was not stipulated (Steiner et al., 2007). Clearly, further research is necessary to establish accurate

proxy pre-illness weights for benchmarking of future diagnostic tests. Both Steiner and Pruvost's studies found that calculated pre-illness weights from previous weights were valid but the number of children with available growth charts may well be too small to make this feasible in practice (Pruvost et al., 2013; Steiner et al., 2007).

Given that contemporary rehydration regimens do not require an exact fluid loss to be calculated, it seems somewhat irrelevant that diagnosing the exact percentage of dehydration is problematic. A categorical assessment thus seems both reasonable and pragmatic but the lack of precision makes it difficult to test empirically. Whilst it is reassuring that severe dehydration is detectable based on clinical signs, the lack of reliability for children with lesser degrees of dehydration means that some children in this group may not be identified. However, it could be argued that such children will either improve as their disease abates and thus suffer few ill effects from being overlooked or if they deteriorate they will develop detectable signs that will elicit treatment. The Rehydration BCB attempts to safeguard such children in two ways; firstly, being able to tolerate oral fluids without ongoing losses are two of the discharge criteria (see appendix C), also the parent information (see appendix J) includes signs of dehydration that parents are directed to watch for that would prompt a return to the ED. Scrutiny of discharges and revisits rates in the future are necessary to confirm whether this approach is appropriate.

The review findings also confirmed that serum bicarbonate and ketones correlated with degree of dehydration with serum ketones having the greatest correlation and serum ketone levels are something that may be relatively easily and inexpensively measured at the bedside using a finger prick sample. However, ketosis is a marker of starvation rather than dehydration and thus these findings may need to be corroborated further to ensure that this relationship is consistent for all causes of gastroenteritis and to derive ranges that could be used to titrate rehydration. Despite the positive predictive value of serum bicarbonate and potentially ketones, if severe dehydration is detectable through clinical signs, there seems no additional value to blood testing for the purposes of diagnosis. In addition, Spandorfer et al.'s (2012) findings, that it was difficult to achieve IV access in the 1-3 year age group, seems to endorse previous views that blood testing may delay rehydration (Spandorfer et al., 2012). To add further credence to the notion that blood

tests are not helpful, Freedman, DeGroot, and Parkin (2014) found that serum bicarbonate levels were not able to independently predict revisit rates (within 7 days) in their secondary analysis report of children who were given IV rehydration (n=226), suggesting that biochemistry may be a poor predictor of recovery (Freedman, DeGroot, et al., 2014).

Digital capillary refill time may offer a promising alternative non-invasive diagnostic tool but further work is required to validate the initial findings and derive ranges for practice. No other non-invasive test reviewed was found to be timely and/or reliable.

Another aspect that was not addressed by the review studies is the detection of electrolyte disturbances, acidosis or hypoglycaemia. This may be because the clinical signs may be difficult to differentiate from those of dehydration. For instance, Madati and Bachur (2008) undertook a cohort study (n=130) to create a triage tool for the detection of acidosis; they applied a regression tree analysis to their sample and identified that children younger than 2 years of age and with dry mucous membranes or duration of illness of more than 2 days were more likely to be at risk of acidosis (Madati & Bachur, 2008). Ironically, dry mucous membranes, as discussed previously, has a high degree of subjectivity and is therefore arguably not a reliable sign. Similarly, Reid et al. (2003) studied 180 children with gastroenteritis and compared those with hypoglycaemia to those with normal blood sugar levels using multivariate analysis and whilst being female, having vomiting predominant symptoms and altered neurology was associated with hypoglycaemia, the predictive value of these signs was not statistically meaningful (Reid et al., 2003). However, altered mental status is a characteristic of severe dehydration (see Figure 1) and these children would have an IV cannula sited and their biochemistry assessed prior to rehydration (Canavan & Arant, 2009; Desselberger & Gray, 2013; Van den Bruel, Haj-Hassan, Thompson, Buntinx, & Mant, 2010; Wathen et al., 2004; Woolley & Burton, 2009). This provides some validation for the use of IV rehydration for this group as it promotes the detection of biochemical imbalances.

Theme Two: The route of rehydration in children with gastroenteritis

This review confirmed that enteral rehydration is as effective as IVF for correcting mild to moderate dehydration in children and is associated with fewer risks (Colletti et al., 2010;

Dalby-Payne & Elliott, 2011; Nager & Wang, 2002; Pieścik-Lech, Shamir, et al., 2013; Rimon & Freedman, 2010). Enteral rehydration may also be associated with reduced length of stay, admissions and revisits. The latter was noted irrespective of disease severity suggesting that parents may view children as being more unwell if they receive IVF and thus more likely to return (Freedman, Thull-Freedman, et al., 2013). No studies in this review examined NG rehydration for correcting severe dehydration. Given that severely dehydrated children with gastroenteritis are at the greatest risk of altered biochemistry and other morbidities, have reduced intestinal absorption and that one of the adverse effects seen with NGT rehydration is paralytic ileus, it seems reasonable that IVF are used for this group until safety testing can be completed.

Another possible future route for rehydration was subcutaneously administered fluids. These may be useful when NG fluids are not feasible (i.e. child is too large or vigorous to feasibly pass the tube and/or keep the tube in situ) as an alternative to IVF (especially in the under three years age group where IV catheter placement maybe particularly troublesome). Early results suggest that subcutaneous fluid administration may be superior to IV fluids in terms of efficacy, successful catheter placement, tolerance and cost-effectiveness (Marikar, Reynolds, & Rich, 2014; Sasson & Shvartzman, 2001; Spandorfer, 2011; Spandorfer et al., 2012). However, recombinant human hyaluronidase is required to facilitate capillary uptake of fluid; a product that is not currently licensed, available or funded in New Zealand and this would need to be addressed before this route could be trialled.

Theme Three: The volume/rate of rehydration fluids to be given to children with gastroenteritis

No studies in the review effectively validated or refuted the rehydration rates in the BCB of 15mL/kg/hour for 4 hours for IV or NG rehydration. For NG rehydration rates of 25mL/kg/hour for 4 hours were found to be effective and prevented IVF and hospital admissions and reduced LOS (Powell et al., 2011). No study evaluated the use of 25mL/kg/hr for 4 hours via the IV route but the review studies did show that IV rates from 25-100mL/kg/hr were well tolerated and were not associated with serious adverse reactions (aside from a worsening metabolic acidosis from chloride administration in the

100mL/kg/hour regimen) but the measurement of efficacy within these studies was not undertaken reliably. This suggests that rapid rehydration with rates of 15-25mL/kg/hour for four hours are safe and historical studies have found them to be effective. However, this aspect of rehydration continues to have the most meagre and disparate evidence.

Theme Four: The type of fluid used in the rehydration of children with gastroenteritis

As no study included the particular brand of ORS used in New Zealand (Pedialyte Bubble Gum®), it is not possible to comment on its efficacy specifically. However, its components are consistent with WHO recommended ORS standards and these do have proven efficacy (Atia & Buchman, 2009; Munos, Walker, & Black, 2010; World Health Organization, 2005). The two studies by Passariello and colleagues also suggested that the addition of zinc to ORS may reduce the duration of diarrhoea; Pedialyte Bubble Gum® contains about one tenth the amount of Zinc compared to the ORS formulation trialled so the effectiveness of this is unclear (Passariello et al., 2015; Passariello et al., 2011). The studies included did confirm that taste and palatability impacts on ORT success. Freedman, Cho, Boutis, Stephens, and Schuh (2010) undertook taste testing with 66 children of various fruit flavoured ORS; Pedialyte® was found to be more palatable than others tested including rice base products but the specific flavours were not listed (Freedman, Cho, et al., 2010). No other studies could be found that compared the relative merits of the various Pedialyte® flavours so it is unclear whether or not the bubble gum flavour is the most popular. Given the cost savings, it could be argued, that taste testing or alternative flavours should be made available and funded to maximise the likely success of ORT.

The use of NSD5 for IV rehydration within the BCB was indirectly endorsed by the review findings. The addition of 5% Dextrose improved serum ketone levels and 0.9% Sodium Chloride prevented acquired hyponatraemia. However, none of the studies reviewed evaluated the volumes used in the BCB. Thus, whilst the use of this fluid is supported and the volumes are supported, the use of NSD5 at BCB rates and volumes was not explicitly tested.

Theme Five: Adjuncts used in the treatment of children with gastroenteritis

The results endorsed the use of Ondansetron to mitigate ongoing vomiting and enhance ORT success. Its use is associated with cessation in vomiting, reduced risk of IVF, admission and cost savings. The impacts on revisit rates are inconsistent and the adverse effect of increased stool output was cited in some studies. Regardless of this the use of Ondansetron is endorsed based on the best available evidence. Some authors even support dispensing or prescribing further doses of Ondansetron to reduce the chance of revisits and there is some modest evidence that this may be successful (Xu & Rieder, 2014). Other anti-emetics such as Domperidone, Dimenhydrinate and Granisetron were found to be ineffective or inferior to Ondansetron for children with gastroenteritis.

Studies evaluating Racecadotril (an anti-diarrhoeal agent) were included within this review and it was found to reduce the duration of diarrhoea by one day and to reduce costs associated with secondary care requirements. Its use is supported by NICE but it is not included in any of the other clinical guidelines retrieved. Racecadotril is a selective enkephalinase inhibitor and works by reducing water and electrolyte secretion without affecting gut motility, in the trials reviewed no adverse effects were noted (Rimon & Freedman, 2010). In contrast, Loperamide is a synthetic opiate that activates opioid receptors leading to a reduction in peristalsis; whilst it has been found to be effective, in this review it was associated with severe adverse events including death resulting from sepsis in young children (Dalby-Payne & Elliott, 2011; Kent & Banks, 2010). It would appear that the transit of stool may have a role in removing the causative pathogen from the body and thus drugs that impede this may increase the risk of systemic infection. Several other anti-diarrhoeal medications are described in the literature but none were included in the studies reviewed or have wholesale endorsement for their use in children with gastroenteritis and thus will not be further discussed here.

One agent that was confirmed in this review to be effective for reducing the duration of diarrhoea was zinc, although sub-group analyses from historical studies indicate it is only helpful in children over 6 months of age and is most helpful in children who are zinc deficient (Rimon & Freedman, 2010). Zinc helps to maintain gastrointestinal epithelial barrier integrity and enhances tissue repair and immune function. It is widely used in the

developing world (Rimon & Freedman, 2010). However, few guidelines support its use in developed countries because fewer children have malnutrition and are therefore less likely to suffer zinc deficiency and also because zinc supplements must be taken twice a day for two weeks to be effective (Guarino et al., 2014). Most guidelines agree that the cost and inconvenience is not likely to afford significant benefits for children with normal nutrition and largely short lived gastroenteritis (Fleisher, 2015; Matson, 2015b).

Probiotics were also shown to reduce duration of diarrhoea in multiple studies both within and prior to this review. This effect was seen both in community and inpatient settings; the latter was associated with reduced length of hospitalisation for children with gastroenteritis. Whilst the quality of evidence is low or very low, the consistency of effect to some degree offsets these deficits. Indeed, ESPGHAN endorses the use of probiotics for the treatment of gastroenteritis with the strongest strength of recommendation for Lactobacillus GG and Saccharomyces boulardii and a weaker strength of recommendation for L reuteri DSM 17938 and L acidophilus LB (heat-inactivated) (Szajewska, 2015; Szajewska, Guarino, et al., 2014). Outside of Europe, probiotic use is not widely described and a significant barrier is that they are not classified as medications but as health supplements; access and funding are therefore likely to pose some challenges. However, there is emerging interest in the use of probiotics; with increasing numbers of studies demonstrating their efficacy in the treatment or prevention of a number of conditions such as necrotising enterocolitis in neonates, acute diarrhoea, antibiotic associated diarrhoea, eczema and other atopy (Thomas & Greer, 2010). In relation to gastroenteritis, one product, Ethical Nutrients Gastro Relief™, is marketed that contains both of the most effective strains described above. In the short term, a possible intermediate step maybe to include the possible benefits of probiotics and the effective strains in the parent information. Clearly this may disadvantage children from lower income families posing an ethical conundrum and additionally it could be seen that mentioning specific products may constitute advertising adding an additional potential conflict of interest. It seems therefore, that the sourcing, use and funding of probiotics for medical conditions will need to be addressed in New Zealand in the near future.

Theme Six: Parental Advice

The review findings support the historical view that there is no benefit to delaying re-feeding; there were no adverse effects reported for early re-feeding with very poor and inconsistent evidence that the duration of diarrhoea might be reduced with early re-feeding. Whilst not covered in this review there is also historical support for not diluting milk feeds and avoiding high sugar fluids (Ciccarelli et al., 2013; Gregorio et al., 2011; Lebenthal & Lebenthal, 2001; Shapiro et al., 2010). No study evaluated the maintenance fluid requirements post rehydration but logic would dictate that volumes that are equivalent to the usual daily intake plus replacement of ongoing losses are likely to be effective for maintaining hydration. However, there is a paucity of evidence assessing how parents interpret this, how well they cope with this at home, and how much fluid they actually administer to their children which is a possible area for further study. Additionally, ongoing insensible losses from fever are not accounted for which has unclear significance and has not been measured in this context. Nevertheless, the same argument for categorical hydration assessment may apply here, in that children will either improve as they recover from their disease or worsen and develop signs of severe dehydration which would prompt returning to the ED. Once again, audit of the WDHB revisit rates will validate whether or not the volumes suggested are achievable and effective after discharge. No studies addressed the issue of breast feeding but the historical evidence is supportive of this, although no specific guidelines are offered (Guarino et al., 2014).

The final issue is that of lactose free feeds. The BCB suggests continuing usual feeds, whereas, the review findings show that lactose free feeds were found to reduce the duration of diarrhoea by about 18 hours. However, whilst this is statistically significant, one could question whether the benefits are sufficient to justify the expense, inconvenience and practical issues associated with changing to lactose free feeds. Changing feeds may also negatively impact on the child's willingness to drink which may disrupt fluid intake and increase the risk of enteral hydration failure.

As a side issue, it is acknowledged that the BCB does not consider whether or not the written parent handout is the most effective medium of information transfer; other

modalities may be more effective and certainly languages other than English need to be produced. This is something that does warrant future consideration.

Implications for Practice

This final section will complete the discussion of the review findings. Firstly, the gaps in the literature and areas that require further research in the management of gastroenteritis will be identified. This will be followed by an exploration of how the BCB should be evaluated and the future of the BCB. The wider implications for practice will be briefly discussed and lastly, the original aims of the study will be revisited and validated.

Gaps in the Literature

In some respect the term "gaps" is inaccurate in this context. Given that there are many disparities in both the primary research relating to gastroenteritis and in the ensuing clinical guidelines, the word "consensus" may be more pertinent. The number of studies published on this subject is large and new studies are emerging every year, there is often poor consistency in their findings which may or may not be due to their often low to very low quality. Further research may help to confirm which interventions consistently emerge as superior but only if such studies are of high quality. In particular, the areas of gastroenteritis management that do require further study to reconcile previous conflicts and to validate new approaches include: development and endorsement of benchmarks for definitive assessments of dehydration, validation of the safety of categorical dehydration assessments as well as digital capillary refill measurement, point of care ketone testing, flavour preferences of ORS and volumes/rates of rehydration.

Clinical guidelines for gastroenteritis also lack consistency which may simply reflect a lack of consensus in the evidence they are based on, although the variance in quality and rigor described by Van den Berg and Berger (2011) may also be a factor. Another consideration is that given the rate and volume of new studies, the time required for the development of guidelines may in fact render them virtually obsolete by the time they are published. This suggests that clinical guidelines need to be reviewed and updated regularly to remain credible.

Evaluating the BCB

Evaluating the BCB is likely to be complex as there are three distinct but integral components: The actual interventions, the structured approach to care delivery (timed assessment and intervention points) and the fact that it is nurse initiated; empirically it may prove challenging to discern the impact of each. In the literature, IV rehydration, admission rates and revisits are commonly used to measure efficacy of gastroenteritis treatments and these will be most likely to reflect the contribution of the BCB interventions themselves (Boyd et al., 2005; Colletti et al., 2010; Fox et al., 2012; Freedman, Ali, Oleszczuk, Gouin, & Hartling, 2013). Determining parental knowledge and/or confidence to continue care at home would also indicate how successful the parent information component of the BCBs was (see Appendix J).

To evaluate the structured approach, the obvious outcome measure would be ED LOS as this should be reduced if treatment was initiated and completed promptly. However, ED LOS is used as a quality indicator in part because long waiting times are associated with reduced patient satisfaction and there is political mileage in reducing wait times (Bongale & Young, 2013). Whilst it may reflect efficiency, it could just as easily signify premature disposition decisions or incomplete care and is also affected by ED patient volumes, therefore, it may not be an accurate measure of quality (Browne et al., 2000; A. J. E. Carter & Chochinov, 2007; Jelinek et al., 1999; Jones et al., 2012). Indeed, longer LOS arguably may be permissible if admission rates are reduced, i.e. if it means that more children who previously would have been admitted are discharged following successful rehydration, as reduced admission rates are associated with cost savings. This is at odds with the Shorter Stay in the ED targets as DHBs are penalised if they are not compliant (Ministry of Health, 2013). Furthermore, patient satisfaction may be improved even with extended LOS if their treatment was initiated early; thus time-to-treatment data or patient satisfaction scores may be more helpful in the evaluation of the structured approach than ED LOS alone.

Nurse initiated care is reliant on nursing staff recognising certain conditions as well as their effective assessment and implementation of treatments. This may be seen as an extension of the traditional nursing role as they are required to make diagnostic decisions and initiate treatment without prompting by a physician (Lister, 1997; Lyneham,

Parkinson, & Denholm, 2008). Whilst the BCB aims to upskill nurses through the workbook (see appendix E) there is a risk that some nurses may feel uneasy undertaking this role, or that BCBs will be commenced in error. The latter would be revealed by auditing BCB compliance and the former through an evaluation of nurses' satisfaction and/or confidence with the BCBs. Similarly, physicians may resent nurses commencing treatment before they have seen a patient, or the use of a pathway that is not consistent with their preferred approach. This is data that would be captured through research into their satisfaction. Clearly, the empirical evaluation of the BCBs will require a comprehensive approach and will need to employ both quantitative and qualitative methods and there is likely to be some overlap between the measures for each component.

The future of the BCB

A number of issues emerged that may be considered for future inclusion in the BCB. Digital capillary refill technology and serum ketone testing may offer a quick, reliable and objective method of detecting dehydration[4], although further work is needed to corroborate initial findings. Whilst bladder scanning was not found to be useful diagnostically, its use may be helpful to evaluate rehydration interventions and this is something that could be explored further. Subcutaneous fluid administration may offer a simple alternative to IV fluids in those children for whom IV access is difficult; however, the sourcing and licensing of recombinant human hyaluronidase and fluid delivery guidelines would be necessary precursors for any practical trial. Racecadotril may be useful in preventing revisits for ongoing diarrhoea, although this too would first require the pursuance of supply, licensing and funding in New Zealand. Given that the use of Racecadotril will incur a cost to the ED it would also be necessary to empirically evaluate whether the number of children who return to the ED for ongoing diarrhoea would justify this expense. The endorsement of probiotics to reduce the duration of diarrhoea is credible but fraught with issues. As supplements are not medications, there are practical barriers to their prescription, supply and funding. For commercially prepared supplements, there is no legislative framework to ensure such products contain the

[4] Albeit that serum ketones actually reflect starvation rather than dehydration, however, serum ketone may emerge as a proxy marker of hydration after further study.

effective strains in adequate doses and there may be professional conflicts that prevent the endorsement of particular brands. The inclusion of the effective strains in the parent handout may circumvent this issue in the short term. Finally, lactose exclusion is not currently included in the BCB as the modest benefits were not felt to justify the practicalities of changing feeds; for persistent diarrhoea (>5 days) it may seem worth the inconvenience and this may be added to the parental advice sheet. The above discussion highlights the fact that new evidence continues to be published and constant perusal of the literature and regular appraisal of the BCB interventions is required to ensure it stays contemporary. This is an issue that will be planned for by the BCB development team. Finally, as mentioned above future consideration of alternative mediums for knowledge transfer to parents needs to be evaluated and explored further as reliance on the written word may not best serve this purpose.

Wider practice issues

This review has revealed several issues relating to practice in the ED and beyond. Evidence based practice is widely described as being desirable to inform interventions and to promote improved patient outcomes (Avis & Freshwater, 2006; Barth et al., 2012). However, the reality is there is increasing volumes of evidence and it may not be feasible for individuals to systematically appraise the literature for every issue. Clinical guidelines (and the pathways that are derived from them) may offer a solution, as the evidence is consulted and appraised by the development team to facilitate evidence based practice. However, this notion may be overly idealist given that there are often multiple guidelines in existence and, as has been discussed, their content and quality are often inconsistent. Given that contemporary, nursing and medical education programs teach critical appraisal skills and evidence based practice, it may be argued that poorly written guidelines are thus rightly challenged (Limmer, Mistovich, & Krost, 2008; Lu & Li, 2013; Van Dijk et al., 2010). However, this is likely to reinforce scepticism in such documents which may taint their acceptance of imposed guideline use in practice. Accordingly, there is an onus on guideline developers to ensure they employ adequate rigor and for clinical leaders to ensure that the guidelines they support are credible.

Revisiting the study aims

The original intent of this review was to validate the BCB interventions, identify additional or alternative interventions and to produce a summary of the evidence to include in the BCB guidance. The findings and discussion have largely validated the interventions within the Rehydration BCB and a few additional or future interventions have also been established. The evidence summary (see Table 4) provides a useful overview of the study findings and also serves to not only endorse the BCB interventions but to demonstrate the breadth of supporting evidence that was considered. It is hoped that including this in the BCB package will increase the credibility of the BCB and that it may persuade dissenters of its merits and increase its uptake in practice.

Limitations

There were several limitations to this study. The inclusion of studies published in the last five years and in English was an attempt to contain the scale of the review but at the cost of an arguably incomplete dataset. However, this did ensure that the contemporary management of gastroenteritis was highlighted, although it is likely that evidence from other databases and grey material were still overlooked which may have limited study findings. Excluding studies that were undertaken only in developed countries increased the relevance of the studies retrieved as the aetiology, level of healthcare, nutrition and housing are likely to be different in developing countries and all of these may affect the outcomes for gastroenteritis.

In terms of methodology, a modified systematic review approach was taken which meant that the appraisal of studies was less in depth than it would have been using the GRADE method or other systematic review methodologies. Also, no attempts were made to pool statistics as there was such a wide degree of heterogeneity between the studies in terms of definitions of diarrhoea, inclusion criteria, sample selection, how dehydration was assessed, outcome measures and approaches to data analysis (based on published data); thus it was felt that any attempts to merge data seemed likely to be futile and flawed (Johnston et al., 2010). Given the time period available it was also not feasible to source primary data for analysis. This links to another issue; it was originally intended to generate

strengths of recommendations. However, this proved impossible because, whilst the systematic reviews were generally of good quality the studies they reviewed often were not or the quality of each study for each outcome was not stated explicitly. Any recommendations would have been inherently flawed and not credible so they were not formulated (Djulbegovic, Kumar, Kaufman, Tobian, & Guyatt, 2015).

Finally, as a member of the BCB development team, it could be argued that this author may be biased towards favouring the BCB. Whilst every effort was made to provide a balanced and objective opinion, this does need to be considered.

In conclusion, this review has endorsed the Rehydration BCB interventions and whilst the review was necessary to add credence to its use, this is just one of many steps that will be required to establish whether the WDHB BCBs will deliver on the promise of safer, effective and timely care. Ongoing work is required to maintain its relevance and to consider the inclusion of future innovations. However, it seems clear that BCBs and similar innovations are changing the nature of emergency medicine and blurring the lines between traditional professional roles in an attempt to meet increasing demands.

Table 4: Summary of Validation of BCB interventions

BCB Interventions	Summary of Findings	Recommendations	Quality of Evidence
Theme One: Assessment of the degree of dehydration in children with gastroenteritis 8 Studies (SR= 2, RCT=1, CS=5, EE=0)			
Categorical assessment of dehydration.	Review findings support historical view that clinical signs are more useful in combination and accuracy is only significant for severe dehydration (high specificity but lower sensitivity). For mild and moderate dehydration clinical signs may over diagnose dehydration.	Categorical assessment of dehydration seems pragmatic and reasonable.	Very low to low
Blood testing only undertaking with initiation of IV fluids not to diagnose dehydration	Review findings support correlation between serum ketones and bicarbonate with degree of dehydration but more so for severe dehydration.	If severe dehydration is detectable through clinical signs there is no additional value to blood testing for the purposes of diagnosis. There may be a place for serum ketone point of care testing but this requires further validation.	Low
Theme Two: The route of rehydration in children with gastroenteritis 6 Studies (SR= 2, RCT=2, CS=1 EE=1)			
Oral rehydration promoted	Review findings support the use of oral rehydration with ORS for patients with mild to moderate dehydration.	ORT is as effective as IV rehydration for children with mild and moderate dehydration with fewer serious adverse effects and is associated with fewer admissions and revisits.	Very low to low
Nasogastric rehydration is prompted if oral fails or is unfeasible at 0, 60 & 120 minutes (in rehydration pathway).	Review findings support the use of NG rehydration with ORS where oral rehydration failed.	NG is as effective at IV rehydration for children with mild and moderate dehydration with fewer serious adverse effects and is associated with fewer admissions and revisits.	Low
Intravenous rehydration only indicated for severe dehydration, large volume ongoing losses and failure of oral rehydration where nasogastric rehydration is unfeasible.	No review studies compared enteral and IV rehydration for severe dehydration. No historical studies were found that evaluated the use of enteral rehydration for severe dehydration in children with gastroenteritis.	Historical consensus suggests that IV volume expansion is indicated for patients with severe dehydration and shock.	Very low

BCB Interventions	Summary of Findings	Recommendations	Quality of Evidence
Theme Three: The volume of rehydration fluids to be given to children with gastroenteritis? 5 Studies (SR= 0, RCT=3, CS=2, EE=0)			
15mL/kg/hour for 4 hours in rehydration pathway.	Review studies found 15mL/kg/hr for 4 hours to be safe and effective for IV rehydration. No review studies examined this rate for enteral rehydration. This rate is described historically in several gastroenteritis guidelines.	There is historical consensus that 15mL/kg/hour for up to 4 hours (enteral and IV routes) is safe and effective.	Very low
Increased to 25mL/kg/hour for 4 hours for ongoing losses	Review studies showed rapid nasogastric rehydration at 25mL/kg/hr was more effective than standard rehydration over 24 hours. No included studies looked at IV rehydration at these rates but they have been included in published clinical guidelines.	Rehydration at 25mL/kg/hr for 4 hours (enteral and IV routes) is safe and effective.	Very low
Theme Four: The type of fluid used in the rehydration of children with gastroenteritis? 4 studies (SR= 0, RCT=3, CS=1, EE=0)			
Oral rehydration fluid (low sugar)	No review studies evaluated the efficacy of low osmolality ORS. Several historical studies have found that low osmolality ORS reduced the need for IVF and admission as well as morbidity and mortality.	There is plentiful historical evidence that ORS promotes rehydration and reduces the need for IVF or admission.	Very low
5% Dextrose and 0.9% Sodium Chloride IV fluids	Review studies support the use of isotonic Sodium Chloride solutions for IV rehydration to prevent acquired hyponatraemia. Review studies support the addition of 5% Dextrose to IV rehydration for lowering serum ketone levels.	0.9% Sodium Chloride plus 5% Dextrose is a safe and effective solution for IV rehydration for children with gastroenteritis.	Low

BCB Interventions	Summary of Findings	Recommendations	Quality of Evidence
Theme Five: Adjuncts used in the treatment of children with gastroenteritis. 18 studies (SR= 8, RCT=5, CS=4, EE=1)			
Ondansetron administration for ongoing vomiting	Review studies support the use of Ondansetron to terminate symptoms of vomiting, to prevent ORT failure and to prevent IVF and admissions. It may be associated with increased diarrhoea episodes.	Ondansetron use is associated with increased ORT success and reduces the risk for IVF requirement and admission.	Low
Theme Six: Parental Advice 4studies (SR= 3, RCT=0, CS=0, EE=0)			
Restart normal feeds as soon as possible	No increased risks associated with early re-feeding.	There is no benefit for delaying refeeding.	Low

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List of Appendices

Appendix A: Permission Letter

Waitemata District Health Board
Best Care for Everyone

To: Jane Key

24th August 2015

From Willem Landman (Clinical director WDHB Emergency Medicine)

Dear Jane

I Willem Landman, as Clinical Director of WDHB Emergency Medicine have ownership of all documents pertaining to Best Care Bundles. I agree to the inclusion of the following materials pertaining to the WDHB Rehydration Best Care Bundle in your Masters dissertation (for an indefinite period and including both printed and digital copies):

- Rehydration BCB pathway
- Rehydration BCB clinical notes
- Rehydration BCB background document
- Oral rehydration form
- IV prescription form
- Ondansetron standing orders
- PCNS competencies
- RN workbooks

Signed

LANDMAN

Willem Landman

Department of Emergency Medicine
EMERGENCY DEPARTMENT
AUCKLAND • NEW ZEALAND

Appendix B: Underlying Guideline Document

REHYDRATION BCB GUIDELINES

Table of Contents

REHYDRATION BCB GUIDELINES

Purpose

The purpose of this Best Care Bundle (BCB) is to provide a clear pathway for the management of dehydration in children. The BCB is designed to enable the prompt assessment of these children thus ensuring they receive appropriate care in a timely fashion.

1. Definition: Rehydration BCB

- Dehydration is a very common cause of morbidity and mortality in children
- Dehydration is a common symptom of many disease processes; however, it is something that can be managed in a standardised way, which is safe and effective.
- One of the most common causes of dehydration is **gastroenteritis**, which is often recognised as diarrhoea with, or without, the presence of vomiting.
- Approximately 1 in 50 children born each year in developed nations is hospitalised for acute gastroenteritis at some point in their childhood
- These children are easy to identify, be started on the BCB and benefit from nurse-initiated treatment as guided by standing orders.
- Those who are likely to benefit from admission are also identified sooner thus resulting in shorter stays in the Emergency Department.
- The aetiology of gastroenteritis can be viral, bacterial or parasitic. Improvements in public health have resulted in decreased frequency of bacterial and parasitic causes but viral gastroenteritis continues to account for approximately 7 – 10% of hospitalisations each year in children under the age of 18 years.
- The majority of presentations are over the winter months during which time gastroenteritis can account for up to 20 – 25% of all presentations to the ED.
- More than 95% of children who are hospitalised with viral gastroenteritis are under the age of 5 years, and the majority of these are between the ages of 3 – 24 months due to loss of protective passive maternal immunity.

This bundle promotes early recognition and management of children with dehydration irrespective of the aetiology. This allows improved consistency of patient care and improved outcomes, children who do not follow the expected pathway can also be recognised earlier and managed appropriately.

REHYDRATION BCB GUIDELINES

2. Scope

Clinicians who use this BCB can be Registered Nurses, Paediatric Clinical Nurse Specialists and Medical staff.

Registered Nurse (RN)

The BCB is designed to be nurse initiated.
The Registered Nurse:

- Places the child on the BCB according to the Inclusion Criteria.
- Completes an initial assessment of the child.
- Assesses the child for relevant Red Flags and initiates a Senior Medical Officer (Senior Dr) review if appropriate
- Uses the ***Hydration Assessment Tool (HAT)*** to assess for features suggestive of dehydration.
- Identifies the child who is not dehydrated and places them on the **Not Dehydrated Pathway**
- Identifies the child who is dehydrated and starts them on the **Hydration Pathway**
- Recognises the child with shock as per the ***Severity Assessment Tool (SAT)***, moves the child to Resus and initiates an urgent medical review as per the **Severe Pathway**.
- Initiates treatment under standing orders as directed by the relevant pathway.
- Re-assesses the child regularly as per the pathway to assess response to the treatment and changes the management accordingly.

Paediatric Clinical Nurse Specialist (PCNS)

PCNS's work within an extended scope of practice under the direct supervision of the Senior Dr. Their extended scope of practice has been agreed on by the Clinical Director of the Emergency Department and the Nursing Head of Department.

Within this BCB they:

- Perform a relevant medical assessment
- Oversee the delivery of either the **Not Dehydrated** or **Hydration Pathways**
- Manage appropriate disposition

The overall responsibility of care of the child remains with the Senior Dr. The PCNS has the responsibility of keeping the Senior Dr informed of all cases they are working on, will seek advice/assistance as indicated and will refer on when appropriate. Upon identification of any Red Flags or if the patient does not respond as expected, a Senior Dr review is mandated.

House Officer and Junior Emergency Medicine Registrar (Junior EM RMO)

Within this BCB the Junior EM RMO will:

- Perform a relevant medical assessment
- Prescribe relevant medication on the Paediatric Medication Chart
- Oversee the delivery of either the **Not Dehydrated** or **Dehydrated Pathways**
- May oversee a child who is on the **Severe Pathway** following a Senior Dr review and under the supervision of the Senior Dr
- Manage appropriate disposition

REHYDRATION BCB GUIDELINES

The Junior EM RMO has the responsibility of keeping the Senior Dr informed of all cases they are working on, will seek advice/assistance as indicated and will refer on when appropriate. Upon identification of any Red Flags or if the patient does not respond as expected, a Senior Dr review is mandated.

Advanced EM Registrar and Senior Medical Officer (Senior Dr)

Within this BCB the Senior Dr will:

- Perform a relevant medical assessment
- Prescribe relevant medication on Paediatric Medication Chart
- Oversee the delivery any child with Dehydration including those who are shocked and are started on the **Severe Pathway**
- Manage appropriate disposition
- Supervise the PCNS and Junior EM RMO

In addition they may prescribe treatment when individualised care is required.

3. Rehydration BCB

The BCB differentiates between the child who has Gastroenteritis and is not dehydrated; the child who is dehydrated based on the ***Hydration Assessment Tool (HAT)*** (See Section 5.1.1) disregardless of the cause of the dehydration; and the child who has features suggestive of severe dehydration according to the ***Severity Assessment Tool (SAT)*** (See Section 5.1.2.)

If the child deteriorates at any time and develops signs of severe dehydration or shock, they are moved to the Resus area and the **Severe Pathway** is commenced. This may occur before a formal nursing assessment has been completed. This mandates an immediate Senior Dr review and involvement of the Paediatric Team. (See Section 5.6)

Inclusion criteria

- Any child who is over the age of 6 weeks who has diarrhoea with or without vomiting. This child would, by definition, have gastroenteritis.
- Any child with dehydration who has been entered onto the BCB by Clinician request. These children could be dehydrated for many reasons, however would be appropriately rehydrated using this BCB.
- Children who are only vomiting can only be managed on this BCB by Clinician request after they have been seen as they do not, by definition, have Gastroenteritis

Exclusion criteria

- Any child who is under the age of 6 weeks
- Dehydration secondary to diabetic ketoacidosis should not be managed on this pathway

If there are any aspects on history that makes it unclear if a patient is suitable for the BCB – they should be discussed with the Senior Dr who is available on the floor, or on ext 3366 at NSH, or ext 7799 at WTH.

REHYDRATION BCB GUIDELINES

Safety Checks/Red Flags

If any Red Flags are noted, an urgent Senior Dr review is warranted, however, the child can meanwhile continue to be managed as per the BCB.

- The most important consideration during the initial evaluation is to recognise serious conditions such as intestinal blockage and raised intracranial pressure for which immediate and definitive care is required
- Severe dehydration with shock – These children need to be moved to Resus, started on the **Severe Pathway** and have an immediate medical review
- A temperature of greater than 39°C or if the child appears toxic - A wider differential diagnosis should be considered and further investigations may be required
- Children with a known metabolic condition – These children may require alternative investigations and specialised resuscitation fluids. They should be discussed with the Paediatric Metabolic Specialist at Starship Hospital.
- Known cardiac issues - These children may be at risk of cardiac failure with sudden changes in intravascular and extravascular fluids
- Absent bowel sounds or suspected ileus – The child may have an intestinal obstruction or lack of peristalsis and will probably not tolerate oral fluids, however following the BCB is still appropriate as these children will be identified and managed accordingly.
- Bloody bowel motions (hematochezia) or Melena – A diagnosis of bacillary dysentery should be considered. If the child is systemically unwell or immunocompromised, empiric antibiotics may be required.
- Bile stained vomiting - This could also be an indication of a intestinal obstruction

If there are red flags a Senior Medical or Paediatric Registrar review should be sought without delay.

REHYDRATION BCB GUIDELINES

4. Assessment Tools

Hydration Assessment Tool (HAT)

The HAT is an objective tool used in this BCB to assess the child for features suggestive of dehydration on arrival and at hourly review points.
The features that are suggestive of dehydration can be any combination of the following:

- Reduced urine output – This is a very good reflection of dehydration. It can be difficult to assess if the child is wearing nappies as urine and loose bowel motions can be indistinguishable
- Recent weight loss – This is the gold standard as it can be an accurate measurement of fluid loss. All children who are seen in the ED are weighed at every presentation and ideally their weight is recorded on their discharge letter. If they have been seen recently, comparing their weights would be the most accurate measure of dehydration. It should be taken into account that different scales can give slightly different values.
- Thirst – Children who are dehydrated are thirsty. As they are rehydrated, this settles and lack of thirst with normal behaviour is a good sign of appropriate rehydration
- Absent tears
- Sunken eyes and fontanelle

Severity Assessment Tool (SAT)

The SAT is an objective assessment tool that helps to recognise children with severe dehydration and who may have signs of shock.

This can include any combination of the following features:

- Tachycardia with small volume pulses
- Delayed capillary refill time
- Cool peripheries
- Limp and drowsy

5. Use of the Pathways

Children are assessed by using the HAT and SAT. They are then placed in one of 3 pathways:

- Those with gastroenteritis but are not dehydrated;
- Those who are dehydrated who need rehydration;
- Those with severe dehydration or shock

If the child deteriorates at any time, they can be moved to the Severe Pathway

REHYDRATION BCB GUIDELINES

Not Dehydrated Pathway

At the start and at each review point, vital signs are recorded and management continued as appropriate.

If the child has frequent, ongoing vomiting and there are no contra-indications, a single dose of Ondansetron can be given as per Standing Order.

Education of the Parent or Caregiver is the mainstay of this BCB. Once the child is discharged home, the parent/caregiver will need to understand the likely duration of the illness and the importance of ongoing management of the child at home. This will ensure that the child receives appropriate management at home, but also that the parent/caregiver recognises when the child needs to return to ED for a review.

Oral Rehydration (ORT) is commenced at 15ml/kg/hour. This is a safe volume for a child to drink and will help prevent dehydration especially if the child continues to have vomiting and diarrhoea. The parent/caregiver is given an Oral Intake Chart (OIC) and told the target volume that needs to be given to their child over the next hour. As per the OIC this can be given via syringe, bottle or cup depending on what the child would prefer. They are encouraged to record this on the OIC.

After an hour, at review, the RN will review the OIC and document on the BCB the oral intake in the previous hour. The HAT is then used again. If, over this time period, the child has become dehydrated, they are then moved to the Hydration Pathway. If they are not dehydrated, are tolerating ORT and they have not yet been seen by a clinician, the RN is encouraged to initiate a review as discharge seems imminently feasible. Once again the parent/caregiver is given a target volume of ORT to give to their child.

Ideally the child will be seen within 1 – 2 hours. If they remain well hydrated and are tolerating ORT, they can be discharged if discharge criteria are met.

Rehydration Pathway

At the start and at each review point, vital signs are recorded and management continued as appropriate.

If the child has frequent, ongoing vomiting and there are no contra-indications, a single dose of Ondansetron can be given as per Standing Order.

Education of the Parent or Caregiver is the mainstay of this BCB. Once the child is discharged home, the parent/caregiver will need to understand the likely duration of the illness and the importance of ongoing rehydration of the child at home. This will ensure that the child receives appropriate management at home, but also that the parent/caregiver recognises when the child needs to return to ED for a review.

Oral Rehydration (ORT) is commenced at 15ml/kg/hour. The parent/caregiver is given an Oral Intake Chart (OIC) and told the target volume that needs to be given to the child over the next hour. As per the OIC this can be given via syringe, bottle or cup according to the child's preference. They are encouraged to record this on the OIC so that on review after an hour, the RN can assess the intake and manage the child as per the Pathway. If oral rehydration is not feasible for some reason, such as the child being exhausted or the parent/caregiver unable to administer ORT, an NGT can be inserted and ORT commenced at 15ml/kg/hr. If oral rehydration is not feasible and a NGT is not appropriate for whatever reason, an intravenous line (ivl) is inserted. Bloods are take to check the electrolytes and iv fluids are commenced at 15ml/kg/hr

REHYDRATION BCB GUIDELINES

After an hour, the RN reviews the progress on the OIC and records the intake over the preceding hour on the BCB. A series of questions are then asked. Each option needs to be considered.

- If the child has become severely dehydrated at any time as according to the SAT, or if bloods have been taken and the Sodium is either less than 130mmol or greater than 170mmol, the child is immediately moved to Resus and they are started on the **Severe Pathway**.
- If they are tolerating oral or NG fluids and have achieved the *target volume*, they continue with ORT at the same rate. The target volume for the next hour is calculated and the parents are encouraged to continue with ORT.
- If they are not achieving target volumes orally, a Nasogastric tube (NGT) is inserted and rehydration continues at 15ml/kg/hour
    - However, if they are not achieving target volumes and a NGT is felt to be unfeasible for whatever reason, then an intravenous line (ivl) is inserted. Bloods are take to check the electrolytes and iv fluids are commenced at 15ml/kg/hr
- If the child is having *excessive losses* (See definition below) the ORT can be increased to 25ml/kg/hr either orally or via NGT. If the child already has an ivl in place, the rate can be increased to 20ml/kg.
    - If the sodium has been checked, and is over 150mmol, the intravenous fluid rate should not be increased and an urgent doctor review is warranted
    - If the child is already on maximal rates, and is dehydrated with excessive losses an urgent clinician review is mandatory as this child has the potential of having a life threatening illness
        - *Excessive losses* are assessed as more than 2 large loose bowel motions in an hour. As each bowel motion is approximately 10ml/kg, two bowel motions would be 20ml/kg and if rehydration is being given at 15ml/kg/hour, the child will obviously be getting more dehydrated.

The same decisions are repeated hourly for the second and third hours.

At 4 hours a <u>disposition decision</u> needs to be made.

- If the child is severely dehydrated or has a blood Sodium level >170mmol or <130mmol, they are moved to Resus and started on the **Severe Pathway**
- If the child has been appropriately rehydrated (recognised by either passing urine and/or no longer having features of dehydration) and does not have excessive losses, they can be discharged if discharge criteria are met (See Section 7)
- If they are still dehydrated then they will need to be referred to the Paediatric Team for a review
    - While they are awaiting the review, ongoing management needs to be continued to ensure that the child does not more dehydrated in the meantime.

The cumulative intake at discharge or time of referral is calculated and documented.

Severe Pathway

Any child who is shocked is moved to Resus immediately and an immediate Medical review is mandatory. The Paediatric Team would like to be informed immediately as well. All management is as directed by the Medical Staff however some recommendations are provided.

All causes of shock need to be considered.

The nurses are encouraged to attach monitoring equipment, check the blood sugar level and prepare an immediate 20ml/kg fluid bolus of normal saline. This may need to be repeated.

REHYDRATION BCB GUIDELINES

The Senior Dr or Paediatric Team should manage any child that ends up in Resus. Immediate intravenous access should be obtained, however this is often extremely difficult is a severely dehydrated child so the recommendation is to only attempt 3 times and then to insert an intraosseous (IO) needle.

Electrolytes should be checked – this can be done via a capillary blood gas if an IO has been used. The results need to be checked as soon as possible as these children will often have abnormal Sodium levels.

A fluid bolus of 20ml/kg should be given immediately and this can be repeated as per Clinician request. The clinician will also decide on on-going investigations and management.

6. Admission

Refer for admission if:

- The child is dehydrated despite the initial treatment
- The child is requiring ongoing IV treatment
- The child is requiring ongoing NG treatment
- There is a high risk of deterioration
    - Significantly high volume ongoing losses – More than 2 large diarrheas per hour – this approximately equates to >20ml/kg/hour of losses. This is felt to be in excess of what a family could cope with at home with oral rehydration
    - Under the age of 6 months – as these children can dehydrate rapidly
    - Other co-morbidities
- Any other significant concerns – this could include social concerns, time of night, where they live, transport issues, history of poor compliance etc.

If they are to be admitted, this BCB encourages an early referral to the Paediatric in-patient team following Senior Dr review. This should happen within 3 – 4 hours children who are still dehydrated or have significant on-going losses will be identified by this time.

If the child needs to be referred to PICU, this needs to be arranged and documented

Children at WTH need to have been seen by the Senior Dr and referred to the Paediatric team via the Paediatric Registrar. Ongoing treatment must be charted.

Children at NSH will also need a Senior Dr review and the Paediatric Registrar will need to be called. Fluids and any possible medications that may be required en route need to be charted. Then transport can be organized and the child transferred from NSH to WTH.

7. Discharge

The child can be discharged home if the discharge criteria are met as per the Discharge Guidelines.

Discharge Guidelines

- Patient *reviewed by Senior Dr* or Pediatric Registrar if the child is not an ED patient
- Discharge letter with an appropriate prescription has been completed and given to the parents
- An additional dose of Ondansetron can be dispensed for use at home as required per Standing Order – Prescriber to complete the instructions on the medication including patient details and lock out time (time after which an additional dose of Ondansetron can be taken such as 8 – 12 hours after previous dose)

REHYDRATION BCB GUIDELINES

- On-going symptom management plan explained and the Parent/Caregiver feels confident in being able to manage at home and also know who to contact if they have concerns
- Follow up has been arranged if required with either *Homecare for Kids* or their GP

Patient Information Handouts

- Gastroenteritis

8. Process

Aim to be completed within the first 30 minutes

Step	
1	Triage Assessment
2	Initial Nursing Assessment
3	HAT applied and appropriate pathway started
4	Commence treatment as directed by pathway

TRIAGE NURSE	• Triage Nurse does a rapid assessment in the triage area • The patient is moved to an appropriate location according to Australasian Triage Scale such as the paediatric area or Resus as required
ASSESSMENT NURSE	• Primary assessment is done by the assessment nurse (Using the Paediatric Assessment Triangle), which is then documented on the Children's Emergency Assessment Sheet. • Reviews inclusion criteria, initiates and commences BCB documentation. • Records the Initial Nursing Assessment on the BCB • Identifies any Red Flags and instigates immediate Senior Dr review if identified • Assesses hydration, determines the target volume required and commences appropriate treatment pathway on the BCB • Completes all relevant fields on the BCB document • Educates the parent/caregiver about Rehydration
RN/PCNS/Medical Staff	• Initiate BCB on Whiteboard.

Aim to complete within 60 minutes

If the BCB pathway has so far been solely managed by a RN, a review by a Clinician such as a PCNS, House Officer, Registrar or Senior Dr is required.

REHYDRATION BCB GUIDELINES

Step	
1	Clinician review
2	Medical Assessment documented
3	Continue with appropriate pathway

Clinician	• Reviews patient and complete the Medical Assessment documentation on page 5 and 6
	• Reviews treatment efficacy up to that point
	• If the clinician involved in the case is a PCNS, an Advanced EM RMO or Senior Dr review is required to:
	  ▪ Review Clinical Impression/Problem List
	  ▪ Ensure any additional medications required are charted in the Paediatric Medication Chart
	• If the clinician involved is a doctor:
	  ▪ Documents a Clinical Impression/Problem List
	  ▪ Ensures any additional medications are charted in the Paediatric Medication Chart
	• Considers discharge if suggested by the Pathway

Aim to complete within 4 hours

Step	
1	Clinician review
2	Disposition decision

Clinician	• Reviews patient and documents
	• Ensures all documentation completed
	• Review suitability for discharge or admission
	• PICU admission arranged if required
	• If admission to Rangatira Ward required:
	  o Discusses the patient with the Paediatric Registrar/Consultant
	  o Transfers over the care of the patient on the Whiteboard
	  o Ensures **all ongoing medications** are charted in the Paediatric Medication Chart
	  o If the patient is being transferred from NSH to WTH, arranges appropriate transport with transit nurse and ongoing treatment
	• If patient is to be discharged:
	  o Ongoing treatment explained
	  o Patient Handout given and contents explained
	  o Appropriate medications prescribed
	  o Discharge paperwork completed

REHYDRATION BCB GUIDELINES

Admission Registered Nurse (RN)	▪ If patient to be admitted: o Books a bed o Ensures all clinical notes/observations are up to date o Gives ward clerk complete notes o Gives nursing handover to the ward

9. Supporting documentation

1	BCB
2	Patient Handout
3	RN/CNS competencies
4	Education workbook
5	Standing Orders for Ondansetron
6	Oral Intake Record (Patient)
7	Intravenous Fluid Prescription Order

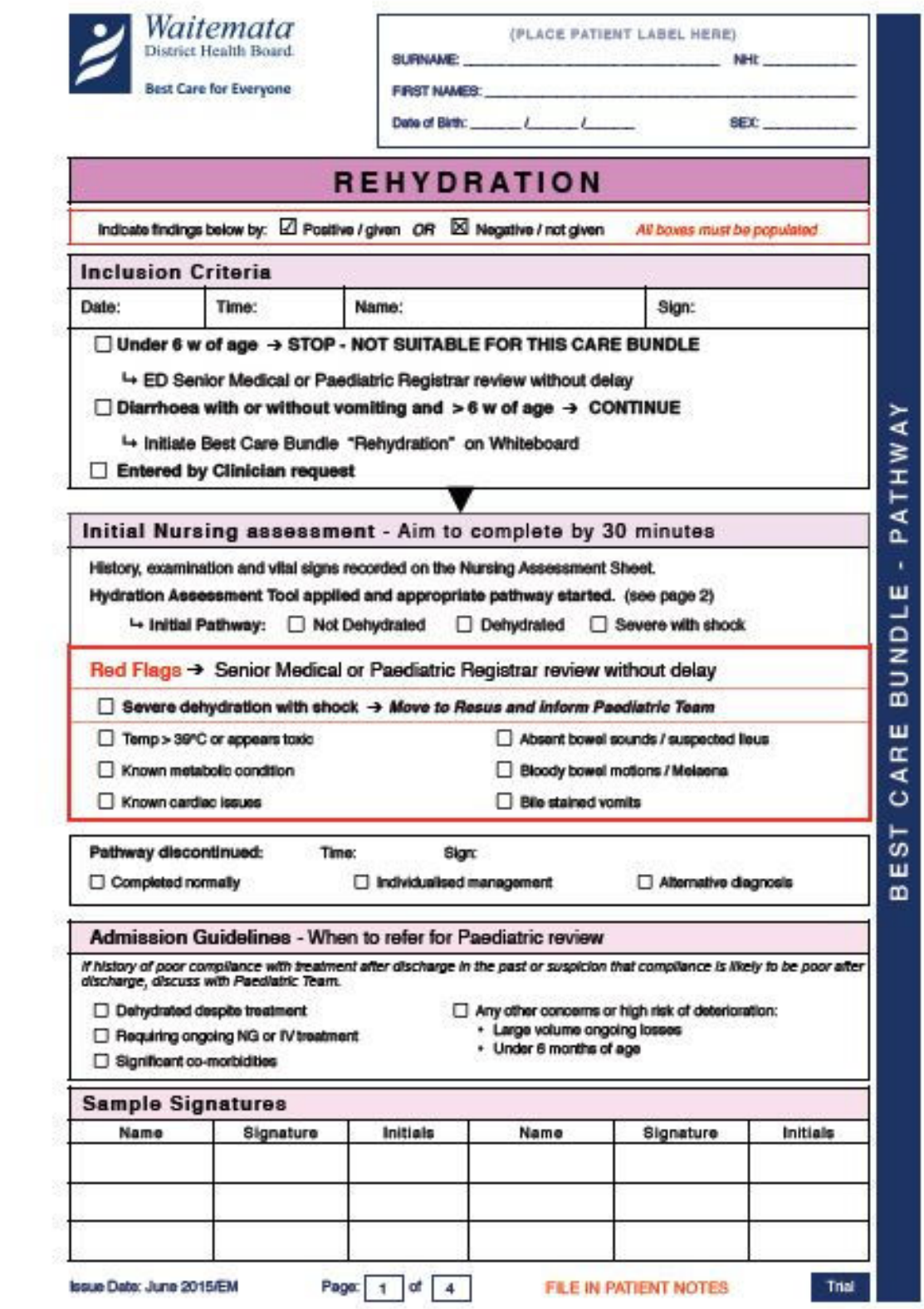
10. Appendix : Supporting literature and References

Policies & Procedures	Ondansetron Standing Order – Paediatrics – WDHB Controlled Documents Ondansetron – WDHB Controlled Documents Hydration BCB Intravenous Fluid Record Oral Intake Record (Parent) Parent Handout

REHYDRATION BCB GUIDELINES

Supporting Literature	Advanced Paediatric Life Support: the practical approach. 5th edition. Advanced Support Group. BMJ Books – Publisher John Wiley & Sons (Wiley-Blackwell) ISBN: 978-1-4443-3059-5 UpToDate Viral gastroenteritis in Children: Epidemiology, clinical presentation, and diagnosis. Updated Jan 14, 2014 UpToDate Viral gastroenteritis in children: Prevention and treatment. Updated July 16, 2014 UpToDate Oral Rehydration Therapy. Updated Jul 12, 2012 UpToDate Approach to the infant or child with nausea and vomiting. Updated Aug 14, 2013 Gastroenteritis in Children: Part II. Prevention and Management. Catherine Churgay et al. American Family Physician Vol 85, No 11. June 2012 Starship Children's Health Clinical Guidelines. Gastroenteritis. Last reviewed June 2006 Diarrhoea and vomiting caused by gastroenteritis. Assessment and management in children younger than 5 years. Clinical guideline April 2009. National Collaborating Centre for Woman's and Children's Health Elliott EJ, Backhouse JA, Leach JW. Pre-admission management of acute gastroenteritis. J Paediatr Child Health. 1996;32:18–21. Reid SR, Bonadio WA. Outpatient rapid intravenous rehydration to correct dehydration and resolve vomiting in children with acute gastroenteritis. Ann Emerg Med. 1996;28:318–23. Is Hyperchloraemic Acidosis a problem in children with gastroenteritis rehydrated with normal saline Arch Dis Child. May 2007; 92(5): 466.

Appendix C: Clinical Pathway Document



Waitemata District Health Board
Best Care for Everyone

(PLACE PATIENT LABEL HERE)
SURNAME: _____ NHI: _____
FIRST NAMES: _____
Date of Birth: ____/____/____ SEX: _____

BEST CARE BUNDLE - PATHWAY

REHYDRATION

Indicate findings below by: ☑ Positive / given OR ☒ Negative / not given *All boxes must be populated*

Inclusion Criteria

Date:	Time:	Name:	Sign:

☐ **Under 6 w of age → STOP - NOT SUITABLE FOR THIS CARE BUNDLE**
↳ ED Senior Medical or Paediatric Registrar review without delay
☐ **Diarrhoea with or without vomiting and > 6 w of age → CONTINUE**
↳ Initiate Best Care Bundle "Rehydration" on Whiteboard
☐ **Entered by Clinician request**

Initial Nursing assessment - Aim to complete by 30 minutes

History, examination and vital signs recorded on the Nursing Assessment Sheet.
Hydration Assessment Tool applied and appropriate pathway started. (see page 2)
↳ Initial Pathway: ☐ Not Dehydrated ☐ Dehydrated ☐ Severe with shock

Red Flags → Senior Medical or Paediatric Registrar review without delay

☐ **Severe dehydration with shock → *Move to Resus and inform Paediatric Team***

☐ Temp > 39°C or appears toxic
☐ Known metabolic condition
☐ Known cardiac issues
☐ Absent bowel sounds / suspected ileus
☐ Bloody bowel motions / Melaena
☐ Bile stained vomits

Pathway discontinued: **Time:** **Sign:**
☐ Completed normally ☐ Individualised management ☐ Alternative diagnosis

Admission Guidelines - When to refer for Paediatric review

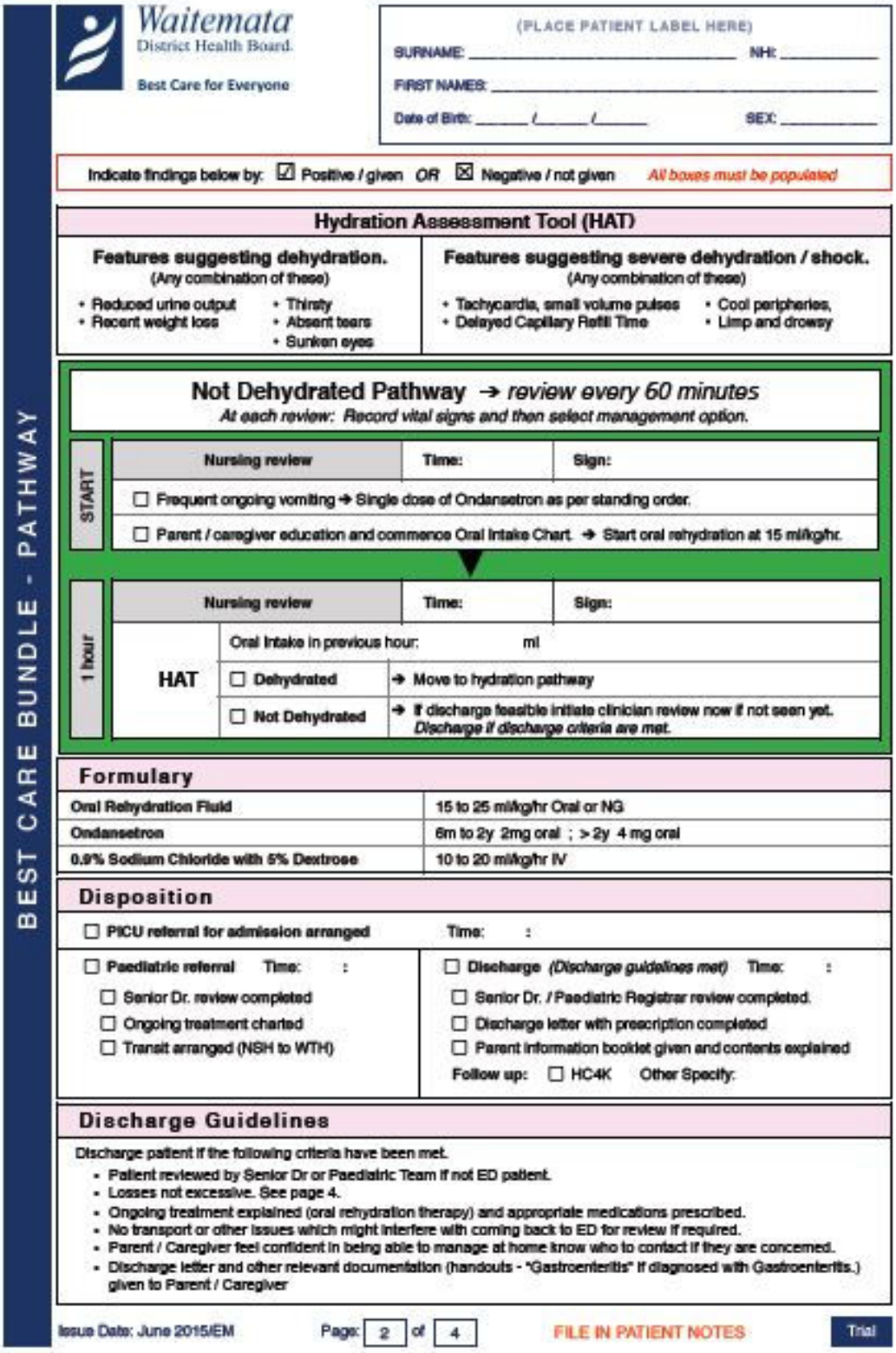
If history of poor compliance with treatment after discharge in the past or suspicion that compliance is likely to be poor after discharge, discuss with Paediatric Team.

☐ Dehydrated despite treatment
☐ Requiring ongoing NG or IV treatment
☐ Significant co-morbidities
☐ Any other concerns or high risk of deterioration:
- Large volume ongoing losses
- Under 6 months of age

Sample Signatures

Name	Signature	Initials	Name	Signature	Initials

Issue Date: June 2015/EM Page: 1 of 4 FILE IN PATIENT NOTES Trial



BEST CARE BUNDLE - PATHWAY

Waitemata District Health Board
Best Care for Everyone

(PLACE PATIENT LABEL HERE)
SURNAME: _____ NH: _____
FIRST NAMES: _____
Date of Birth: ____/____/____ SEX: _____

Indicate findings below by: ☑ Positive / given OR ☒ Negative / not given *All boxes must be populated*

Hydration Assessment Tool (HAT)

Features suggesting dehydration. (Any combination of these)	Features suggesting severe dehydration / shock. (Any combination of these)
• Reduced urine output • Recent weight loss • Thirsty • Absent tears • Sunken eyes	• Tachycardia, small volume pulses • Delayed Capillary Refill Time • Cool peripheries, • Limp and drowsy

Not Dehydrated Pathway → *review every 60 minutes*

At each review: Record vital signs and then select management option.

START

Nursing review	Time:	Sign:
☐ Frequent ongoing vomiting → Single dose of Ondansetron as per standing order.		
☐ Parent / caregiver education and commence Oral Intake Chart. → Start oral rehydration at 15 ml/kg/hr.		

1 hour

Nursing review	Time:	Sign:
HAT	Oral Intake in previous hour: ml	
	☐ Dehydrated → Move to hydration pathway	
	☐ Not Dehydrated → If discharge feasible initiate clinician review now if not seen yet. *Discharge if discharge criteria are met.*	

Formulary

Oral Rehydration Fluid	15 to 25 ml/kg/hr Oral or NG
Ondansetron	6m to 2y 2mg oral ; > 2y 4 mg oral
0.9% Sodium Chloride with 5% Dextrose	10 to 20 ml/kg/hr IV

Disposition

☐ PICU referral for admission arranged Time: :

☐ Paediatric referral Time: :
- ☐ Senior Dr. review completed
- ☐ Ongoing treatment charted
- ☐ Transit arranged (NSH to WTH)

☐ Discharge *(Discharge guidelines met)* Time: :
- ☐ Senior Dr. / Paediatric Registrar review completed.
- ☐ Discharge letter with prescription completed
- ☐ Parent information booklet given and contents explained

Follow up: ☐ HC4K Other Specify:

Discharge Guidelines

Discharge patient if the following criteria have been met.
- Patient reviewed by Senior Dr or Paediatric Team if not ED patient.
- Losses not excessive. See page 4.
- Ongoing treatment explained (oral rehydration therapy) and appropriate medications prescribed.
- No transport or other issues which might interfere with coming back to ED for review if required.
- Parent / Caregiver feel confident in being able to manage at home know who to contact if they are concerned.
- Discharge letter and other relevant documentation (handouts - "Gastroenteritis" if diagnosed with Gastroenteritis.) given to Parent / Caregiver

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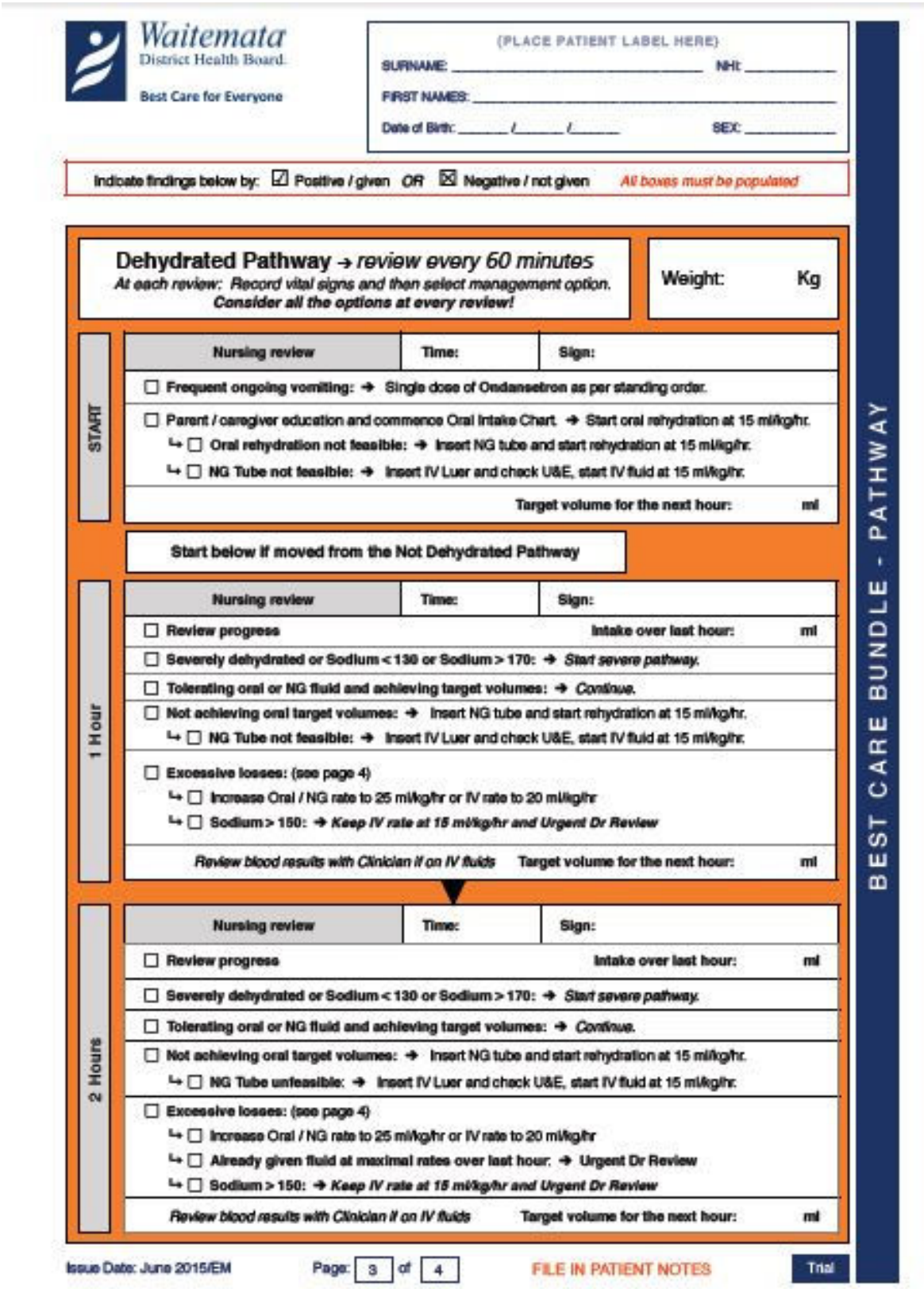

Waitemata District Health Board
Best Care for Everyone

(PLACE PATIENT LABEL HERE)
SURNAME: _____ NHI: _____
FIRST NAMES: _____
Date of Birth: ___/___/___ SEX: _____

Indicate findings below by: ☑ Positive / given OR ☒ Negative / not given *All boxes must be populated*

Dehydrated Pathway → *review every 60 minutes*
At each review: Record vital signs and then select management option.
Consider all the options at every review!

Weight: Kg

START

Nursing review	Time:	Sign:
☐ Frequent ongoing vomiting: → Single dose of Ondansetron as per standing order.		
☐ Parent / caregiver education and commence Oral Intake Chart. → Start oral rehydration at 15 ml/kg/hr.		
↳ ☐ Oral rehydration not feasible: → Insert NG tube and start rehydration at 15 ml/kg/hr.		
↳ ☐ NG Tube not feasible: → Insert IV Luer and check U&E, start IV fluid at 15 ml/kg/hr.		
Target volume for the next hour: ml		

Start below if moved from the Not Dehydrated Pathway

1 Hour

Nursing review	Time:	Sign:
☐ Review progress — Intake over last hour: ml		
☐ Severely dehydrated or Sodium < 130 or Sodium > 170: → *Start severe pathway.*		
☐ Tolerating oral or NG fluid and achieving target volumes: → *Continue.*		
☐ Not achieving oral target volumes: → Insert NG tube and start rehydration at 15 ml/kg/hr.		
↳ ☐ NG Tube not feasible: → Insert IV Luer and check U&E, start IV fluid at 15 ml/kg/hr.		
☐ Excessive losses: (see page 4)		
↳ ☐ Increase Oral / NG rate to 25 ml/kg/hr or IV rate to 20 ml/kg/hr		
↳ ☐ Sodium > 150: → ***Keep IV rate at 15 ml/kg/hr and Urgent Dr Review***		
Review blood results with Clinician if on IV fluids — Target volume for the next hour: ml		

2 Hours

Nursing review	Time:	Sign:
☐ Review progress — Intake over last hour: ml		
☐ Severely dehydrated or Sodium < 130 or Sodium > 170: → *Start severe pathway.*		
☐ Tolerating oral or NG fluid and achieving target volumes: → *Continue.*		
☐ Not achieving oral target volumes: → Insert NG tube and start rehydration at 15 ml/kg/hr.		
↳ ☐ NG Tube unfeasible: → Insert IV Luer and check U&E, start IV fluid at 15 ml/kg/hr.		
☐ Excessive losses: (see page 4)		
↳ ☐ Increase Oral / NG rate to 25 ml/kg/hr or IV rate to 20 ml/kg/hr		
↳ ☐ Already given fluid at maximal rates over last hour: → Urgent Dr Review		
↳ ☐ Sodium > 150: → ***Keep IV rate at 15 ml/kg/hr and Urgent Dr Review***		
Review blood results with Clinician if on IV fluids — Target volume for the next hour: ml		

BEST CARE BUNDLE - PATHWAY

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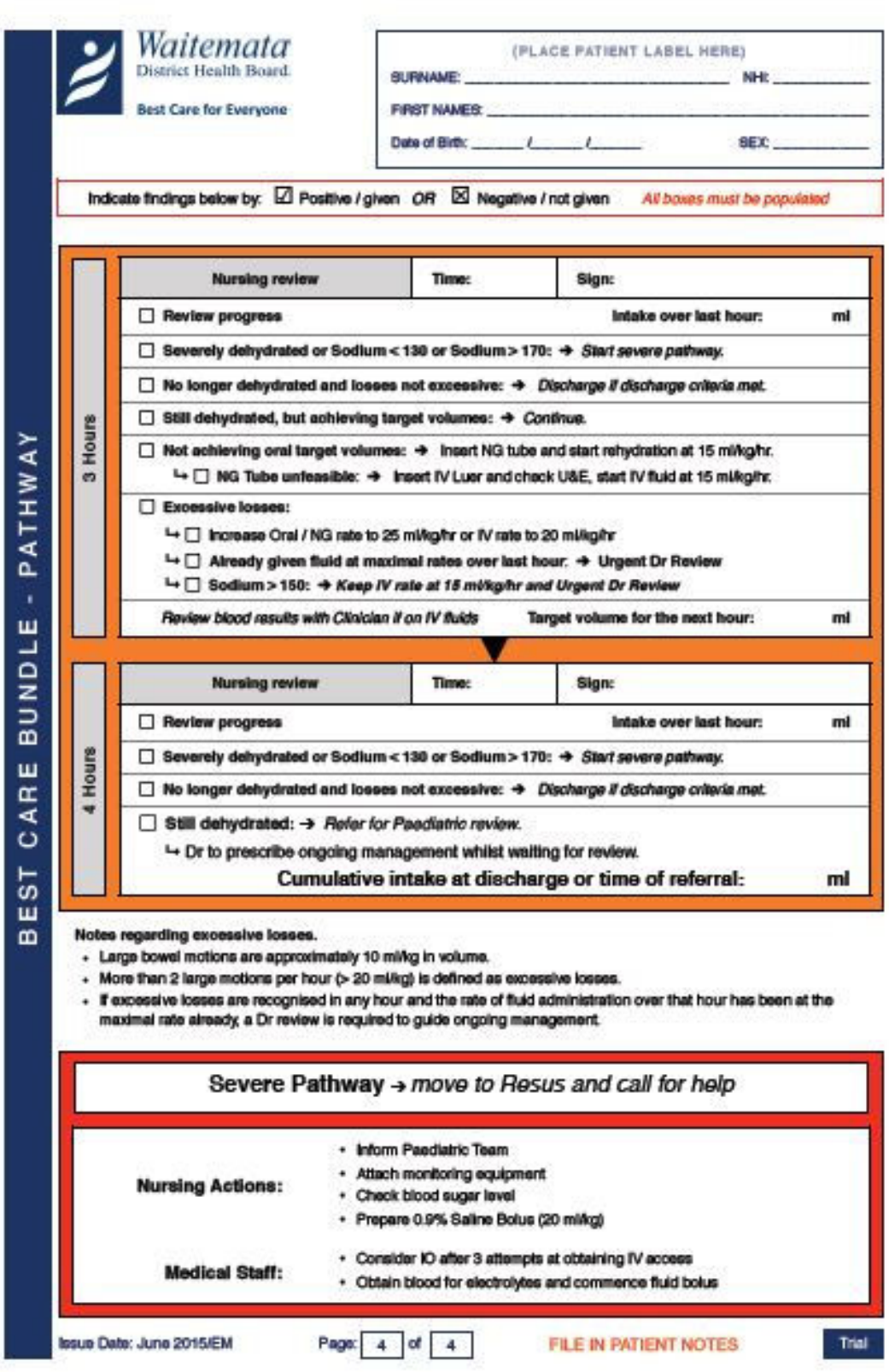

BEST CARE BUNDLE - PATHWAY

Waitemata District Health Board
Best Care for Everyone

(PLACE PATIENT LABEL HERE)
SURNAME: _____ NHI: _____
FIRST NAMES: _____
Date of Birth: ____/____/____ SEX: _____

Indicate findings below by: ☑ Positive / given OR ☒ Negative / not given *All boxes must be populated*

3 Hours

Nursing review	Time:	Sign:
☐ Review progress	Intake over last hour:	ml
☐ Severely dehydrated or Sodium < 130 or Sodium > 170: → *Start severe pathway.*		
☐ No longer dehydrated and losses not excessive: → *Discharge if discharge criteria met.*		
☐ Still dehydrated, but achieving target volumes: → *Continue.*		
☐ Not achieving oral target volumes: → Insert NG tube and start rehydration at 15 ml/kg/hr. ↳ ☐ NG Tube unfeasible: → Insert IV Luer and check U&E, start IV fluid at 15 ml/kg/hr.		
☐ Excessive losses: ↳ ☐ Increase Oral / NG rate to 25 ml/kg/hr or IV rate to 20 ml/kg/hr ↳ ☐ Already given fluid at maximal rates over last hour: → Urgent Dr Review ↳ ☐ Sodium > 150: → *Keep IV rate at 15 ml/kg/hr and Urgent Dr Review*		
Review blood results with Clinician if on IV fluids	Target volume for the next hour:	ml

4 Hours

Nursing review	Time:	Sign:
☐ Review progress	Intake over last hour:	ml
☐ Severely dehydrated or Sodium < 130 or Sodium > 170: → *Start severe pathway.*		
☐ No longer dehydrated and losses not excessive: → *Discharge if discharge criteria met.*		
☐ Still dehydrated: → *Refer for Paediatric review.* ↳ Dr to prescribe ongoing management whilst waiting for review.		
Cumulative intake at discharge or time of referral:		ml

Notes regarding excessive losses.

- Large bowel motions are approximately 10 ml/kg in volume.
- More than 2 large motions per hour (> 20 ml/kg) is defined as excessive losses.
- If excessive losses are recognised in any hour and the rate of fluid administration over that hour has been at the maximal rate already, a Dr review is required to guide ongoing management.

Severe Pathway → *move to Resus and call for help*

Nursing Actions:	• Inform Paediatric Team • Attach monitoring equipment • Check blood sugar level • Prepare 0.9% Saline Bolus (20 ml/kg)
Medical Staff:	• Consider IO after 3 attempts at obtaining IV access • Obtain blood for electrolytes and commence fluid bolus

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Appendix D: Clinical Notes Document

Waitemata District Health Board
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(PLACE PATIENT LABEL HERE)
SURNAME: _____ NHI: _____
FIRST NAMES: _____
Date of Birth: ____/____/____ SEX: _____

REHYDRATION

Indicate findings below by: ☑ Positive / given OR ☒ Negative / not given *All boxes must be populated*

Date: / /20 Time: Clinician: ☐ CNS ☐ HS ☐ REG ☐ SMO

History *See nursing assessment sheet for additional information*

Number of days with diarrhoea (Day of illness): ☐ Vomiting present ☐ Reduced urine output

☐ Infectious contacts Specify:

Relevant past medical history

☐ Prematurity: (Gestation, corrected gestation and BW)

☐ Failure to thrive ☐ Metabolic condition Specify:

☐ Chronic steroid treatment ☐ Con. Heart Disease

Current medications

☐ Ondansetron ☐ Oral Rehydration Fluid ☐ Paracetamol ☐ Ibuprofen

☐ Steroids ☐ Antibiotics Specify:

Examination

General

Appearance: ☐ Alert ☐ Irritable ☐ Drowsy / lethargic

Dehydration: ☐ Nil ☐ Present ☐ Severe +/- signs of shock

Nursing observations: ☐ Normal ☐ Abnormal *(see nursing assessment sheet)*

Ear Nose Throat

Issue Date: June 2015/EM Page: 1 of 2 FILE IN PATIENT NOTES Trial

EMERGENCY MEDICINE - NOTES

EMERGENCY MEDICINE - NOTES

Waitemata District Health Board
Best Care for Everyone

(PLACE PATIENT LABEL HERE)

SURNAME: _____ NHI: _____

FIRST NAMES: _____

Date of Birth: ____/____/____ SEX: _____

REHYDRATION

Indicate findings below by: ☑ Positive / given *OR* ☒ Negative / not given *All boxes must be populated*

Respiratory

☐ Increased work of breathing *(? ketotic / ? acidotic)*

Cardiovascular

☐ Poor volume pulses ☐ Normotensive

Abdomen

☐ Bowel sounds present *(? Ileus)*

Neurological

☐ GCS normal ☐ Irritable (? Hypernatraemia)

Musculo-skeletal

Blood results

Record abnormal results:

Clinical impression / Problem list

Appendix E: RN workbook

REHYDRATION BCB WORKBOOK




INTRODUCTION

The purpose of this workbook is to support nurses working in the Emergency Department to safely and effectively use the Paediatric Rehydration BCB.

This BCB gives a structured approach to the management and assessment of children with dehydration due to gastroenteritis. A clinician may also request a child, who is dehydrated from another cause, to be placed on this pathway when it is safe to do so.

It is important to first consider the pathophysiology of dehydration and why it is essential to identify infants and children at risk and prompt treatment at an early stage.

Please familiarise yourself with the following information – it is a self-learning package and if you require more education/information on this topic please feel free to approach the Paediatric Nurse Educator.

DEFINITION

The terms dehydration and volume depletion are commonly used interchangeably but they refer to different physiologic conditions resulting from different types of fluid loss.

Volume depletion ➔ is the loss of effective circulating fluid within the vessels (intravascular space) i.e. hypovolaemia.

Dehydration ➔ is the loss of total-body water i.e. more water than sodium is lost.

The distinction is important because volume depletion and dehydration can exist independently or concurrently and the treatment for each is different.

Body fluid distribution

The body contains 2 major fluid compartments: the intracellular fluid (ICF) and the extracellular fluid (ECF). The ICF comprises of two thirds of the total body water (TBW), while the ECF accounts for the remaining third and includes intravascular space.

The TBW comprises approximately 70% of body weight in infants, 65% in children, and 60% in adults.

Infants' and children's higher body water content, along with their higher metabolic rates and increased body surface area to mass index, contribute to their higher turnover of fluids and solute. Therefore, infants and children require proportionally greater volumes of water than

adults to maintain their fluid equilibrium and are more susceptible to volume depletion. Significant fluid losses may occur rapidly, leading to depletion of the intravascular volume.

Sodium
Dehydration results in changes in the sodium levels. This can be due to either excessive loss of water resulting in a higher sodium level (hypernatremic dehydration) or replacement of volume depletion with water that does not contain any sodium resulting in a lower sodium level (hyponatremic dehydration).

In ***hyponatremic dehydration,*** the child may appear clinically more ill than actual fluid losses would otherwise indicate and as a result, the degree of volume depletion may be clinically overestimated. (e.g. A child with diarrhoea who has been given water to replace diarrhoeal losses. Free water is replenished, but sodium and other solutes are not).
Serum sodium levels less than 120 mEq/L may result in seizures especially if the sodium levels have changed suddenly. This is due to the excess free water within the vessels shifting into the cells resulting in cerebral oedema. Therefore both water and sodium need to be replaced to prevent this shift from happening.

Hypernatremic dehydration is due to either more free water lost or excessive sodium intake (e.g. Rehydration of a child with concentrated formula or salty soup). The degree of volume depletion may be underestimated and the child may appear to be less clinically ill than fluid losses indicate. This may result in water shifting out of the cells with resultant shrinkage of the cells. This can result in intracerebral haemorrhage, seizures, coma, and death. Too rapid correction of this can result in the rapid shifting of fluid back into the cells again resulting in cerebral oedema. ***For this reason, volume restoration should be performed gradually over 24 hours or more to slowly correct the sodium levels. Gradual restoration prevents a rapid shift of fluid across the blood-brain barrier and into the intracellular fluid compartment.***

Potassium
Potassium shifts between intracellular and extracellular fluid compartments occur more slowly than free water shifts. Serum potassium levels may not reflect intracellular potassium levels. Although a potassium deficit is present in all patients with volume depletion, it is not usually clinically significant. However, failure to correct for a potassium deficit during volume replacement may result in clinically significant hypokalaemia. Potassium should not be added to replacement fluids until adequate urine output is obtained.

Acid and base problems
The most common acid-base derangement that occurs with volume depletion, especially in infants, is *metabolic acidosis*. Mechanisms include bicarbonate loss in stool, ketone production from starvation, and lactic acid production from decreased tissue perfusion in hypervolemia. Decreased renal perfusion also causes decreased glomerular filtration rate, which, in turn, leads to decreased hydrogen (H+) ion excretion. These factors can combine to produce a metabolic acidosis. The mainstay of treatment is rehydration.

Causes of Dehydration
Dehydration may be broadly divided into 3 categories:

1. Decreased intake due to diseases such as stomatitis
2. Increased output from diarrhoea and vomiting or from osmotic diuresis due to uncontrolled diabetes mellitus
3. Increased insensible losses such as with fever

Paediatric dehydration is frequently the result of increased output from gastroenteritis, characterized by vomiting and diarrhoea.

Treatment of Dehydration
Dehydration is a common complication of illness observed in paediatric patients presenting to the Emergency Department (ED). ***Early recognition and early intervention*** are important to reduce risk of progression to hypovolemic shock and end-organ failure.

Laboratory studies are of limited utility in cases of mild dehydration, but they may be considered under certain conditions and are recommended in patients with more severe dehydration. Mild or moderate volume depletion should be treated with **oral rehydration therapy (ORT)**. This includes the use of NGT if required to administer oral fluids.

Intravenous fluid therapy is necessary when oral therapy fails or volume depletion is severe.
Rehydration Facts

- This BCB looks at the management of children presenting with dehydration.
- Acute gastroenteritis is a very common childhood illness occurring worldwide, the most threatening complication of this is dehydration. Therefore the treatment of gastroenteritis is focussed on preventing dehydration.
- A child with **minimal or no dehydration** should be encouraged to continue his or her usual diet plus drink adequate fluids. Many studies have shown that a child's regular diet reduces the duration of diarrhoea.
- Oral rehydration therapy with a rehydration solution can be used to treat diarrhoea in children with **mild to moderate** dehydration.
- Ondansetron can decrease vomiting or help avoid the need for intravenous fluid, but it increases episodes of diarrhoea.
- Probiotics can be used to shorten the course of diarrhoea.
- Good hand washing reduces the incidence of acute gastroenteritis, but not rotavirus or norovirus.

Inclusion Criteria
This BCB is for all children who present **over 6 weeks of age with diarrhoea** with or without vomiting. Clinicians can also request to put a child who is dehydrated from another cause on the bundle.

Red Flags- ***Senior Medical or Paediatric Registrar review without delay***

- **Severe dehydration with shock** – these children need to be moved to Resus and commenced on the Severe pathway with immediate Medical Review
- **Temp > 39°C or appears toxic** – wider range of differential diagnosis to be considered and further investigations may be required
- **Absent bowel sounds / suspected Ileus** – There may be an intestinal obstruction or lack of peristalsis and the child will probably not tolerate oral fluids
- **Known metabolic condition** – These children may require alternative investigations and specialised resuscitation fluids and will need to be discussed with the Paediatric Metabolic Specialist at Starship Children's Hospital
- **Bloody bowel motions / Melaena** – The child may have bacillary dysentery, and empiric antibiotics should be considered

- **Known cardiac issues** - These children may be at risk of cardiac failure with sudden changes in intravascular and extravascular fluids so rehydration needs to be individualised
- **Bile stained vomits** – this could also be a sign of intestinal blockage

The Red Flags are to alert you to children who may have complications from gastroenteritis or may not have gastroenteritis and another diagnosis may need to be considered by the clinician. Most importantly these red flags should alert you to more serious conditions such as intestinal blockage or raised intracranial pressure requiring immediate medical attention. Any child you are concerned about should be reviewed by a doctor as soon as possible.

Initial Nursing Assessment
The first step is to assess how hydrated the infant/child is. This is done using the Hydration Assessment Tool **H.A.T.**

Hydration Assessment Tool (H.A.T)
Features Suggesting Dehydration *Any combination of these:* • Reduced urine output • Recent weight loss • Thirsty • Absent tears • Sunken eyes
Severity Assessment Tool (S.A.T)
Features Suggesting Severe Dehydration *Any combination of these:* • Tachycardia, small volume pulses • Delayed capillary refill time • Cool peripheries • Limp and drowsy

Hydration Assessment
Reduced urine output – This is a very good reflection of dehydration. It can be difficult to assess if the child is wearing nappies as urine and loose bowel motions can be indistinguishable. If this is the case you may consider applying a urine bag to monitor output.

Recent weight loss – This is the gold standard as it can be an accurate measurement of fluid loss. All children who are seen in the ED are weighed on every presentation and ideally their weight is recorded on their discharge letter. If they have been seen recently, comparing their weights would be the most accurate measure of dehydration.

Thirst – Children who are dehydrated are thirsty. As they are rehydrated, this settles and lack of thirst with normal behaviour is a good sign of appropriate rehydration.

Absent tears – this is a reasonably good sign of dehydration

Sunken eyes and fontanelle – this can be difficult to assess so ask the parents if the eyes seem sunken or different to usual.

Pathways
This BCB has 3 pathways similar to the other Paediatric BCBs. Once you have assessed the child you determine that they are either:

- **Not dehydrated** – a child may have gastroenteritis but still appear well hydrated i.e. is not showing any of the signs in the H.A.T.
  - Ondansetron is given if indicated.
  - Parent education is essential as they need to understand why their children is unwell and the importance of ongoing rehydration
  - Ongoing assessment/reviews until discharge

- **Rehydration Pathway** – These infants and children show signs of dehydration according to the H.A.T. and require close monitoring.

  - Ondansetron is given if indicated.
  - Parent education is essential as they need to understand why their children is unwell and the importance of ongoing rehydration
  - Initially the mainstay of rehydration is orally, or via NGT if the child refuses to drink and it is appropriate for their age. The amount of fluid that the child needs to drink is calculated according to their weight and the *Target volume* for the next hour is recorded on the document. The family needs to be told this volume and be given an *Oral Intake Chart* to record the amount the child drinks via syringe, bottle or the child's own cup. The family can also record ice blocks as well as any other oral intake in the free text box. Any vomits, large loose bowel motions or simple wet nappies also need to be recorded. This is to determine ongoing losses, however if the child is passing urine, this is a good sign that they are reasonably well hydrated.
  - Thereafter the child is reviewed hourly.
    - This involves reviewing the Oral Intake Chart, calculating how much fluid the child has tolerated and recording the intake over the last hour in the BCB.
    - If the child has become severely dehydrated or blood results show Sodium < 130 **(hyponatremia)** or Sodium > 170, (**hypernatremia)** then they need to be moved to the Severe Pathway.
    - If the child is tolerating the fluids and achieving target volumes, the management continues unchanged. Once again the target volume is calculated and recorded on the document and the family is to continue to record the intake on the *Oral Intake Chart*.
    - If the child is not tolerating the target volumes orally then a NGT should be inserted if appropriate. If this is not appropriate, an IVL should be inserted, bloods should be taken to check the electrolytes and IV Fluids commenced at 15ml/kg/hour. The IV fluids for this BCB are always 0.9%NaCl with 5% Dextrose. The doctor needs to sign for this on the *Fluid Balance Chart* with the pre-populated fluid prescription.
    - If the child is having excessive losses which are characterised by more than 2 large bowel motions in an hour (each large bowel motion can be approximately 10ml/kg fluid lost) then the fluid rate needs to be increased
    - If the child has had blood tests, these results need to be reviewed with the clinician.

❖ **Severe Pathway –** These children are moved to Resus and require immediate Medical Review. They will need continuous monitoring, an IVL, bloods taken to check the electrolytes and a fluid bolus administered as soon as possible. (20ml/kg of 0.9%NaCl)

Ondansetron - orodispersible

Ondansetron (orodispersible) is a Standing Order for nurses working in the Emergency Department. This is nurse initiated for the treatment of nausea and vomiting within the rehydration BCB. Please familiarise yourself with this standing order – indications for use, dose and contraindications. This is a controlled document found on the intranet.

Notes regarding excessive losses

- Large bowel motions are approximately 10 ml/kg in volume.
- More than 2 large motions per hour (> 20 ml/kg) is defined as excessive losses.
- If excessive losses are recognised in any hour and the rate of fluid administration over that hour has been at the maximal rate already, a Doctors review is required to guide ongoing management.

Assessments/Reviews

This pathway specifies assessment reviews every hour. At this point the following assessments should take place and be documented appropriately:

- H.A.T and S.A.T signs should be reviewed
- Input/output –on *Oral Intake Chart* or NG/IVF on *Fluid Balance Chart*
- Routine vital signs
- Capillary refill time and GCS/AVPU.

These assessments combined should give you a clear picture of the hydration status of the infant/child.

Additional Documentation

- All assessments need to be documented on the BCB pathway with a time and signature
- Any additional information needs to be recorded in the patients long-sheet (e.g. nursing assessment, repose to antiemetic and or analgesia, referrals and treatment plan etc)
- All medications given – including standing orders – need to be documented clearly in the *Paediatric Medication Chart*
- The *Oral Intake Chart* is used for recording of fluid by both the nurse and the parent. The nurse must first indicate the target volume. The parent then records using the tick boxes how much input and output they manage over the specified time. When this is reviewed, the nurse can sign off that line on the Oral Intake Chart and the parents can continue to record intake and output on the following line
- All fluids administered via an IVL or NG tube must be documented hourly on a *Fluid Balance Sheet* by the nurse including a site check.
- All parents should be given the *Gastroenteritis Handout* early where indicated and have an opportunity to read the information and ask questions.
- If a referral to Home Care for Kids is needed it is filled out on the appropriate internal form

Discharge

- Ensure parent/child has *Gastroenteritis Handout* and understands the information
- Documentation is complete and referrals are made for follow-up where needed

- Guidelines on the back of the BCB for discharge have been considered

Admission

- All Documentation is complete including BCB and *Paediatric Medication Chart*
- Nursing hand-over is given as per guidelines

References

Mange K, Matsuura D, Cizman B, et al. Language guiding therapy: the case of dehydration versus volume depletion. Ann Intern Med. Nov 1 1997;127(9):848-53. [Medline].

King CK, Glass R, Bresee JS, Duggan C. Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy. MMWR Recomm Rep. Nov 21 2003;52:1-16. [Medline].

Steiner MJ, DeWalt DA, Byerley JS. Is this child dehydrated?. JAMA. Jun 9 2004;291(22):2746-54. [Medline].

Included:

- Relevant competencies:
    - Patient Consultation and History Taking
    - Clinical Documentation
    - Patient Disposition
    - Laboratory Investigations
    - Planning and Management of Patient Care
    - Paed specific - Systems examination

Appendix F: Excerpt from PCNS Competency Book

Paediatric CNS Competency Book

Patient Consultation & History Taking

Activity to be Monitored	Individual clinical nurse specialist competency in patient consultation and history taking
Rational	To assess staff competency in patient consultation and history taking
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists in Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guideline – Overview of Assessment • WDHB Communication with In-patients and Families Policy • WDHB Health Information – Privacy General Policy • WDHB Clinical Documentation Policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed • Action plan to be signed by CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Patient Consultation and History Taking

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Communication				
• Provides an appropriate and safe environment for the consultation • Introduces self and role • Uses patient-centred communication • Demonstrates awareness of social, cultural and psychological factors • Demonstrates awareness of non-verbal cues • Aware of potential language differences and acts accordingly • Allows patient and relative time to ask and answer questions appropriately • Provides explanations and information for patient regarding their on-going care • Demonstrates polite, approachable and open communication				
History				

• Demonstrates use of Kipling's six honest men: Who, when, where, what, why & how?
• Uses advanced clinical knowledge and reasoning to question patient
• Demonstrates a clear review of systems
• Obtains relevant medical information E.g. previous medical, surgical, obstetric & gynaecological, mental health or injury history
• Obtains information of social history
• Obtains medication history: prescribed, over the counter, natural remedies and preceding admission medication
• Allergies
• Immunisations including tetanus status
• Ensures screening for :
  ○ SFV
  ○ Smoking				

Documentation				
• Ensures all documentation is legible and clearly signed • Records information in clinical notes • Records all relevant details from consultation • Records all pertinent negatives				

Paediatric CNS Competency Book
Clinical Documentation

Activity to be Monitored	Individual clinical nurse specialist competency in clinical documentation
Rational	To assess staff competency in clinical documentation
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• WDHB Clinical Documentation Policy • ED CNS Clinical guidelines
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed • Action plan to be signed by CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Clinical Documentation

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Clinical Notes				
• Documents findings in clinical notes • Clinical notes are legible and clearly signed • Clinical notes contain relevant patient identification data • Vital signs are documented • Clinical notes contain accurate and comprehensive record of presenting complaint, relevant history, review of systems, record of examination, clinical impression, clear plan and management • Accurate documentation of all procedures and investigations • Completes other relevant documentation e.g. ACC form with relevant read code, ability to work, signature and date				
Electronic Discharge Summary				
• Electronic discharge summary completed at time of discharge • Ensures personal log-in is used to access electronic discharge summary • Correct patient is identified • Correct date and time are entered • Documents correct diagnosis • Uses correct ACC code • Clinical management is summarised, accurate, concise and relevant • Documents procedures • Accurately documents discharge medications • Includes all relevant results e.g. laboratory and radiology • GP advice is appropriately documented • Patient focussed advice is acronym-free and clear to understand • Ensures that planned follow-ups and referrals are included • Signs each copy of the discharge summary • Completes EDS in timely manner to ensure effective hand-over to GP • Ensures content s of discharge summary are explained and understood by patient				

Paediatric CNS Competency Book
Patient Disposition

Activity to be Monitored	Clinical nurse specialist (CNS) competency in safe, appropriate disposition of patient under CNS care from the Emergency Department
Rational	To assess CNS competency in the safe, appropriate disposition of patient under CNS care
Objective(s)	To ensure CNS understands the requirements and achieves 100%
Scope of Audit	All Clinical Nurse Specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guideline – Overview of Assessment • WDHB Communication with In-patients and Families Policy • WDHB Health Information – Privacy General Policy • WDHB Clinical Documentation Policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed and then signed off by the CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Patient Disposition

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
General				
• Discusses disposition plan with the EMS • Provides patient with a clear and full explanation of discharge plan • Checks that patient understands the information given • Provides patient with options regarding referral/follow-up care • Provides patient with relevant advice/information regarding on-going care • Documents care, plan and follow up management in case notes and patient electronic discharge summary (EDS) • Provides patient with appropriate paper work e.g. ACC forms, prescription, other referral forms, advice sheets				
Referral / Follow Up				
• Knows when to refer patient to another service • Ensures referral to another service is appropriate for diagnosis / patient • Provides patient with clear instructions regarding referral/follow up care • Considers and discusses referral options with patient • Is familiar with different referral systems e.g. verbal, telephone, fax, written or other • Completes appropriate referral form • Ensures appropriate handover to other service • Sends appropriate documentation e.g. referral form, x-rays to other service				

Paediatric CNS Competency Book
Laboratory Investigations

Activity to be Monitored	Individual clinical nurse specialist competency in assessing the need for and performing laboratory investigations
Rational	To assess staff competency in assessing the need for and performing laboratory investigations
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guidelines • WDHB Communication with In-patients and Families Policy • WDHB Health Information – Privacy General Policy • WDHB Clinical Documentation Policy • WDHB Infection Prevention and Control policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed and then signed off by the CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Laboratory Investigations

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Investigations				
• Demonstrates critical thinking and rationale for choosing relevant laboratory investigations to aid diagnosis • Aware of contraindications associated with investigations • Discusses procedure risks, benefits or alternatives to patient and/or caregiver/family • Obtains informed consent from patient and/or caregiver/family				
Procedure				
• Prepares correct equipment • Carries out the procedure in accordance with Infection Control and Prevention Policy • Obtains the sample appropriately • Labels the sample correctly at bedside • Completes laboratory request form • Sends sample to laboratory in a timely manner				
Documentation				
• Records information in clinical notes • Accesses results via Concerto/Whiteboard • Documents pertinent results • Provides results on EDS for GP for follow up if required				

Paediatric CNS Competency Book
Planning and Management of Patient Care

Activity to be Monitored	Individual clinical nurse specialist competency in planning and management of patient care
Rational	To assess staff competency in planning and management of patient care
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guidelines – Overview of Assessment • WDHB Clinical Documentation Policy • WDHB Handover Policy • WDHB Informed consent Policy • Appropriate ED CNS Guideline for treatment management
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed • Action plan to be signed by CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Planning and Management of Patient Care

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Planning				
• Interprets history and examination data to formulate appropriate plan of care • Uses advanced reasoning to formulate an impression and differential diagnosis • Demonstrates knowledge of recommended best practice and rationale for requesting appropriate investigations • Instigates initial treatments as appropriate, including analgesia and comfort measures • Discusses patient with Emergency Medicine Specialist (EMS) • Is able to provide EMS with a systematic review of history and examination • Uses appropriate language and anatomical terms to relay information to EMS • Provides EMS with a clear understanding of patients presenting complaint, differential diagnosis and plan				
Management				
• Obtains informed consent from patient • Interprets investigations and diagnostic tests to formulate appropriate management and treatment for patient • Refers to speciality doctors as appropriate providing a clear understanding of presenting complaint, clinical impression, diagnostic reasoning and what further management is required • Uses critical thinking to provide treatment which is recommended best practice and refers to appropriate CNS guidelines • Refers to multidisciplinary team as appropriate • Displays a patient-centred approach which is informed and inclusive				
Documentation				
• Ensures plan and management is clearly documented in clinical notes • Documentation is legible and clearly signed • Ensures referral to speciality is recorded on electronic whiteboard				

Paediatric CNS Competency Book
Radiological Investigations

Activity to be Monitored	Individual clinical nurse specialist competency in radiological investigations
Rational	To assess staff competency in radiological investigations
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guidelines – Radiology guidelines and Overview of fracture management • WDHB Communication with In-patients and Families Policy • WDHB Health Information – Privacy General Policy • WDHB Clinical Documentation Policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS • Action plan to be signed by CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Radiological Investigations

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Radiology request				
• Obtains patient consent and compliance • Carries out a thorough patient assessment prior to requesting the relevant radiological investigations • Ensures correct patient data • Adheres to clinical guides e.g. Ottawa ankle, knee or foot rules • Excludes pregnancy in female patient • X- rays are only requested when a positive or negative result will influence management • Completes the electronic request with concise accurate information				
Patient Care				
• Assesses NV status before and after any interventions • Provides temporary splintage, elevate limb and provides pain relief • Ensures all jewellery is removed that could compromise limb circulation • Ensures that dressings are removed or minimized prior to x ray				
Investigations				
• Demonstrates critical thinking by ordering specific views as required e.g. AP/lateral/oblique, scaphoid views, skyline views or soft tissue views				
Investigations for foreign body				
• Demonstrates awareness that non radio opaque foreign bodies will require ultrasound • Discusses with EMS prior to electronic requesting				

Paediatric CNS Competency Book
Radiological Interpretation

Activity to be Monitored	Individual clinical nurse specialist competency in radiological interpretation
Rational	To assess staff competency in radiological interpretation
Objective(s)	To ensure clinical nurse specialist understands the requirements and achieves 100%
Scope of Audit	All clinical nurse specialists working in the Emergency Department
Relevant Policy(s)/ Associated Documents	• ED CNS Clinical Guidelines – Radiology guidelines, Overview of Fracture management • WDHB Communication with In-patients and Families Policy • WDHB Health Information – Privacy General Policy • WDHB Clinical Documentation Policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by assessor and CNS being assessed • Action plan to be signed by CNM • Copy of completed competency to be retained as part of individual CNS's portfolio

Paediatric CNS Competency Book
Radiological Interpretation

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Criteria	Met	Not Met	N/A	Comments
Radiology interpretation				
• Identifies the x-ray, ensures correct patient, correct date, correct view • Provides a systematic approach to describing the x-ray • Identifies the x-ray using correct anatomical nomenclature • Identifies the fracture pattern • Identifies any deformity, angulation, displacement or rotation • Looks for 2nd fracture • Looks for incidental injuries • Identifies any soft tissue changes, foreign body or other radiological abnormalities				
Follow up				
• Discusses findings with EMS and orthopaedic registrar as appropriate • Checks formal radiology report and manages accordingly				

Paediatric CNS Competency Book
Patient Examination: A Systems Approach

Activity to be Monitored	Individual PCNS observed competency in assessment of children with medical presentations to the ED
Rational	To assess staff competency in assessment and diagnosis of common paediatric conditions.
Objective(s)	To ensure PCNS understands their role in the assessment and management of children in the ED
Scope of Audit	All PCNSs in the Emergency Department
Relevant Policy(s)/ Associated Documents	• PCNS Competency Background Document • WDHB Expanded Practice Approval Process • WDHB Credentialing of Advanced Nursing Practice Roles • WDHB Competence Assessment for Medicine Administration • WDHB Clinical Documentation Policy
Results and Action Plan	• Completed assessment must be discussed with individual being assessed • Outcome and Action Plan to be discussed and signed by both the assessor and the PCNS assessed • Copy of completed competency to be retained as part of individual PCNS's portfolio • Copy of completed competency to be retained by CNE Emergency Department

Paediatric CNS Competency Book
Patient Examination: A Systems Approach

The competency is met when the PCNS meets the following criteria:	
PCNS: ***	**Assessor:**
CNM: Marja Peters	**Date:**

Competencies	Met	Not Met	N/A	Comments
Universal competencies for examination of children				
• PCNS demonstrates skills at communicating with child and parent/caregiver in a manner that illustrates caring for his/her overall well-being by the following actions: • Good communication with child and caregiver 1. Introduction 2. Obtains informed consent 3. Explanation of likely actions and possible outcomes. • Implements behaviours that show respect for child's age, gender, cultural values and personal preferences. • Uses language and communication style that is appropriate to child's current needs. • Is able to interpret vital sign recordings • Is able to describe the paediatric assessment triangle [general appearance, work of breathing and circulation to skin)				
Universal precautions				
• Washes hands prior to beginning exam and whenever hands are in contact with patient's body secretions. • Wears gloves and/or goggles whenever in contact with body secretions, or if there is the potential to be in contact with body secretions. • Protects patient and surfaces from contamination.				
Examination Structure				
• Conducts or modifies examination to ensure the exam progresses in a manner suitable to the age, stage and emotional state of the child.				
Head and Neck				
• Inspects face and cranium for symmetry, shape, general appearance, facial features. • Palpates cranium for masses, lesions, tenderness and fontanels. • Inspects and palpates anterior and posterior lymphatic chains in neck. • Inspects and palpates neck for symmetry,				

Competencies	Met	Not Met	N/A	Comments
alignment, masses, tracheal position. • Is able to discuss relevant differentials for this system.				
Eyes				
• Inspects eyes for symmetry, alignment, strabismus. • Palpates external eye structures and inspects conjunctiva, sclera, and cornea for abnormalities. • Inspects for direct and consensual pupil light reflex, corneal light reflex and cover test. • Uses confrontation test to examine visual fields (peripheral vision) in the school age child. • Inspects for convergence, accommodation. • Tests ocular movements using the 6 cardinal fields of gaze in school age child. • Inspects for red reflex with ophthalmoscope. • Is able to discuss relevant differentials for this system.				
Ears, nose and mouth				
• Inspects ears for symmetry, shape and position. • Inspects and palpates external structures of the ear for masses, lesions and tenderness. • Inspects ear canal for discharge, colour, cerumen, swelling, foreign body using otoscope. Inspects each tympanic membrane for landmarks using otoscope. • Tests gross hearing by using whisper test or bell. • Inspects and palpates nose for symmetry, tenderness. • Inspects and palpates frontal and maxillary sinuses for tenderness in older child. • Inspects for nasal patency. Inspects nasal membranes for discharge, colour, septal deviation, masses, and foreign bodies. • Inspects mouth for shape, mucous membrane hydration and colour.				
• Palpates for presence of lesions, masses and abnormalities in the oral cavity. • Inspects teeth for number, colour, attachment, alignment, decay. • Is able to discuss relevant differentials for this system.				
Chest and Lungs				
• Inspects and palpates anterior chest for masses, lesions, tenderness, symmetry, shape, inspiratory/expiratory effort, respiratory pattern, breast for maturity.				

Competencies	Met	Not Met	N/A	Comments
• Palpates posterior chest bilaterally for masses, lesions and tenderness. Palpates for tactile fremitus and thoracic expansion in the school age child. • Percusses posterior chest bilaterally for organs, masses in the older child. • Auscultates each zone bilaterally using systematic approach over all three areas: anterior, posterior, lateral. • Is able to discuss relevant differentials for this system.				
Cardiac				
• Examines circulatory status of upper and lower extremities, including peripheral oedema and capillary refill (peripheral and central) • Inspects distal extremities for colour, pigmentation • Palpates carotid/brachial, radial, femoral, popliteal and pedal pulses bilaterally. • Inspects and palpates apex for apical impulse (PMI), heave, thrill or bulge. • Auscultates apical heart beat and assess for pulse deficit. • Auscultates over 4 valvular areas for S1 and S2 using bell and diaphragm of the stethoscope for each area. • Is able to discuss relevant differentials for this system.				
Abdomen				
• Inspects abdomen for contour, lesions, scars, malformations, umbilicus. • Palpates lightly over all 4 quadrants for tenderness, masses. Performs deep palpation over all four quadrants. Palpates liver in right upper quadrant • Percusses costovertebral angle for tenderness.				
• Auscultates abdomen over 4 quadrants for bowel sounds. • Examines genitalia and testes in infants. • Is able to discuss signs to rule out peritonism. • Is able to discuss relevant differentials for this system.				
Muskuloskeletal				
• Inspects and palpates TMJ, cervical, sternoclavicular, shoulders, elbows, wrists, hands/fingers, hips, knees, ankles, and feet/toes for symmetry, size, colour, swelling, temperature, tenderness. • Directs child to move shoulder, elbows, hips and knees through age appropriate active range of motion bilaterally, noting any limitation. • Tests for muscle strength of shoulder, elbows, hips and knees. • Inspects and palpates spine for structural				

Competencies	Met	Not Met	N/A	Comments
changes and ROM. Inspects lumbo-sacral area for abnormalities. • Is able to discuss relevant differentials for this system.				
Skin				
• Inspects for lesions, scars, moles, symmetry of creases. • Notes colour, temperature, skin turgor, oedema. • Is able to discuss relevant differentials for this system.				
Neurological				
• Visually inspects head • Palpates cranium for bumps, steps, contusion, including fontanel if appropriate **Peripheral Neurological Assessment** **Gait assessment** • Walk in a straight line • Heal to toe • Walk on toes • Walk on heels				
Limb assessment • Assesses for abnormal movements • Tone • Power: o Shoulder shrug, o Elbow F/E, o Wrist F/E, o Finger F/E, o Finger add/abduction, o Thumb add/ abduction, o Hip F/E, o Knee F/E, o Foot dorsi/plantar flexion, o Toe dorsi/plantar flexion • Reflexes o Biceps o Triceps o Brachioradialis o Patella o Archilles o Plantar reflex o Ankle reflex • Sensation				
Central Neurological Assessment **Assesses orientation (age appropriate)** • Speech • Person • Place • Time **Cranial Nerves** **CN 2, 3, 4, 6**				

Competencies	Met	Not Met	N/A	Comments

• Eyes
  ○ Pupil size and reaction
  ○ Position and conjugate eye movement
  ○ Visual acuity
  ○ Visual fields
  ○ Fundoscopy
 	
CN 5
• Sensation to:
  ○ Forehead
  ○ Cheek
  ○ Chin
 	
CN 7
• Facial symmetry
• Able to
  ○ Raise eyebrows
  ○ Scrunch eyes
  ○ Blow out cheeks
  ○ Bare teeth
  ○ Purse Lips
 	
CN 8
• Hearing
 	
CN 9, 10, 12
• Swallow
• Tongue in midline
• Gag reflex
• Position of uvula
 	
CN 11
• Can turn head to the side against resistance
• Shoulder shrug
 	
• Is able to discuss relevant differentials for this system.
Cerebellar function assessment
• Finger-to-nose movements
• Rapid alternating movements
• Thumb-to-finger
• Heel-to-shin
• Romberg
• Stand on each foot
• Hop
• Nystagmus				

Assess for meningism • Neck stiffness • Brudzinski • Kernig **Infant reflexes** • Moro • Rooting • Palmar grasp • Blinking • Babinski • Sucking				

Appendix G: Ondansetron Standing Order

Ondansetron Orodispersible – Standing Order – Paediatrics ED

1. Overview

This document outlines the treatment of nausea and vomiting with ondansetron orodispersible 4mg tablets.

Presentation and Storage

Presentation	Storage
Ondansetron orodispersible tablets 4mg	Pyxis – Acutes

Indications for Use

- Ondansetron orodispersible tablets are of value in the management of nausea and vomiting in children.
- It should only be prescribed when the cause of vomiting is known, otherwise it may delay diagnosis
- Indications include, but are not limited to Gastroenteritis and Chemotherapy induced nausea.

Note: Ondansetron is **only** licensed in children for the management of nausea and vomiting in children receiving cytotoxics/radiotherapy and in post operative nausea and vomiting, however it is used in the hospital as an antiemetic for children older than 6mths of age in the management of Gastroenteritis.

Scope of Practice

1. This standing order applies to all permanent Registered Nurses employed by WDHB Emergency Departments at NSH & WTK
   - who have successfully completed the Waitemata DHB competence assessment for medication administration
   - who know local procedures/protocols
2. Bureau/Agency nurses must not use this standing order

2. Administration Information

2.1 Dose

Ondansetron can be administered to children > 6mths of age:

- < 10kg - 2mg (half a 4mg tablet) every 12 hrs
- > 10kg - 4mg every 12 hrs

2.2 Administration

- Do not push tablet through foil backing, peel foil back to obtain tablet from blister pack
- Do not open until needed.
- Use tablet cutter to halve dose. Ensure that all equipment is dry otherwise tablet will disintegrate before use.
- Allow oradispersible tablet to dissolve on the tongue. (It will disintegrate immediately)
- May also swallow whole tablet with fluid.

2.3 Assessment

- Check any other medications that the child may be on.
- Check and document their weight for dosing.

Ondansetron Orodispersible – Standing Order – Paediatrics ED

2.4 Patient Information

- Inform parent /caregiver or the patient of the potential risks and side effects of ondansetron.

2.5 Documentation

- Remove Ondansetron from Pyxis by confirming YES to option of "is this for a standing order?""
- Record administration of the ondansetron on the medication chart by administering nurse.
- Check and sign administration by a second competent nurse.

2.6 Mechanism of Action.

Ondansetron is a potent, highly selective $5HT_3$ – receptor antagonist. Its precise mode of action in the control of nausea and vomiting is not known.
Following oral administration, ondansetron is completely absorbed from the GI tract and peak plasma concentrations are obtained approx 1.5hrs after dosing.

2.7 Contraindications and Precautions

- Avoid in patients with a congenital long QT syndrome.
- Avoid using with other medications which prolong QT intervals e.g. erythromycin.
- Correct significant hypokalemia and hypomagnesaemia prior to ondansetron administration.
- Monitor patients with signs of subacute intestinal obstruction as ondansetron is know to increase large bowel transit time.

2.8 Possible Adverse Effects.

Common:

- Headache
- Constipation
- Sensation of warmth or flushing

Uncommon:

- Hiccups
- Hypotension, bradycardia, chest pain arrhythmias
- Movement disorders
- seizures

Special Considerations

- Nil

Drug Interactions

- Nil

3. Audit

In order to ensure that Ondansetron Orodispersible tablets administered by a standing order are done in the safest manner possible, the following audits will be conducted on a monthly basis by the ED department:

Ondansetron Orodispersible – Standing Order – Paediatrics ED

- Pyxis audit:
  a. the total number of times Ondanstron Orodispersible tablets are issued under a standing order,
  b. the percentage of Ondasetron Orodispersible tablets administered under a standing order compared to the total amount dispensed,
  c. a cross check that Ondasteron Orodispersible tablets are only removed from pyxis by staff members who are authorized to do so by this standing order (100% compliance sought).
- Paediatric Medication Chart audit.
  d. A proportion of charts will be selected to review that the documentation standards are being adhered to including the correct medication name, dating, timing, and signatures as well as the completion of the allergy section as a minimum standard.
- Best Care Bundle audit when medications are being administered as part of a Best Care Bundle.
  e. A proportion if Best Care Bundle charts will be audited to review the documentation and adherence to the indications and contraindications for that medication.

4. References

1	BNF for children 2012-2013
2	http://www.medsafe.govt.nz/profs/datasheet/o/ondansetronodt-drlatab.pdf
3	New Zealand National Formulary http://www.nzf.org.nz/nzf_2392.html
5	Martindale 37th Edition

5. Standing Order Authorisation

Reviewed by	Position	Date
Willem Landman	Clinical Director	
Marja Peters /Sue Lamb	Charge Nurse Managers	
Jocelyn Peach	Dir of Nursing & Midwifery	
Pharmacy & Therapeutics Committee		

Appendix H: Oral Intake Form

Waitemata District Health Board

Best Care for Everyone

Oral Intake Order

Place Patient Label Here

Date:

Time:

Page nr:

Oral Rehydration Fluid instructions (Nurse only) Calculate the volume to give at the start and at every review				Parent / Caregiver
	Target volume (ml)	Instructions	Sign	Document other intake here (e.g. Ice blocks)
1				
2				
3				
4				

Waitemata
District Health Board
Best Care for Everyone

Oral Intake Record

Place Patient Label Here

Date:

Time:

Page nr:

Own Bottle or Cup volume (ml)

Parent / Caregiver

1. Start in new section after the nurse has reviewed your progress
2. Carry on in next section if running out of space

Intake				Output			Nurse Only
Breast (min)	Syringes (5 ml)	Bottles	Cups	Vomits	Large motions	Wet nappies (not dirty)	Sign when transcribed
	☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐	☐☐	☐☐ ☐☐	☐☐ ☐☐ ☐☐	☐☐ ☐☐ ☐☐	☐☐	
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	☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐	☐☐	☐☐ ☐☐	☐☐ ☐☐ ☐☐	☐☐ ☐☐ ☐☐	☐☐	

Appendix I: IV Fluid Form

Waitemata District Health Board
Te Wai Awhina

First Name:________________ Gender: ________
Surname: ________________________________
AFFIX PATIENT LABEL HERE
Date of Birth: ______________ NHI#: __________
Ward/Clinic: Consultant

Fluid Balance Record (24 hours) Date:

Time Prescribed	Fluid to be given and Instructions	Volume ml	ml per hour	Prescriber Name and Signature	Signature of Administrators	
	0.9% Sodium Chloride + 5% Dextrose	*1000*				
	Rate: ☐ *15mL/kg/hr OR*					
	☐ *20mL/kg/hr*					
	Consider: ☐ *Add 15mmol KCL*					

Code for output
A = Aspiration, **B** = Bile, **BM** = Bowel Motion, **V**=Vomit, **NG** = Nasogastric, **BL** - Blood Loss, **F** = Fistula, **S** = Stoma

INTAKE									OUTPUT					
			Intravenous			Oral/Gastric			Urine			Other		
Start time	Site/fluid check	Fluid given	Start level	Volume given	Running total	Start level	Volume given	Running total	Time	Volume	Running total	Code	Volume	Running total
24 HOUR TOTAL			INTAKE						OUT PUT					

Fluid Balance Record

Review Date: June 2008

5.10.015

Appendix J: Patient Information Sheet

Waitemata District Health Board
Best Care for Everyone

Discharge Information – Gastroenteritis

What is Gastroenteritis ?

- Gastroenteritis ('gastro') is a bowel infection which causes diarrhoea (runny, watery poo) and sometimes vomiting. The vomiting may only last for a day or two but the diarrhoea can last for up to 10 days.
- Your child may not feel like eating or drinking.
- Gastro can also cause stomach pains and fever.
- Gastro is most commonly caused by a virus so antibiotics will usually not work.
- It is more common and severe in babies and young children.

The main thing to worry about with gastro is dehydration (loss of too much fluid from the body). Babies and young children are more at risk of becoming severely dehydrated than older children and this can happen quite quickly.

How is Gastro Treated?

Your child will recover from gastro usually within 10 days (although it is often less than this) but until that happens the main focus is to give fluids to treat and prevent dehydration. This is done in 3 ways:

1. Normal fluids - this is the fluid they would normally take in a day PLUS
2. Catch up (rehydration) fluids - to replace the fluid they have already lost if they are dehydrated PLUS
3. Replacement fluids – prevents dehydration by giving extra fluid when they have diarrhoea or vomiting.

1 Normal Fluids

Give your child their normal fluid intake. Even if they vomit they ***will*** still absorb some of the fluid. Offer smaller drinks more often to get the same overall amount in.

Continue to give food if your child ***wants*** to eat.

Water, breast milk, formula or cows milk are ideal fluids to use.

2 Catch up (rehydration) fluids

If your child has any of the signs or symptoms of dehydration (see next page) they need catch up fluids.

Paedialyte, breast milk, formula or cows milk can be used for catch up fluids.

When they have no signs of dehydration you can stop the catch up fluids.

3 Replacement fluids

When your child has a large vomit or episode of diarrhoea they lose more fluid. Replacing this fluid will stop them getting dehydrated.

For infants offer them an extra drink after each vomit or episode of diarrhoea.

For older children give them one cup (150-200ml) of fluid for every big vomit or diarrhoea.

Breast fed babies
As it is difficult to judge how much milk they are taking, we suggest offering the breast more often (every 2 hours) and after each vomit or episode of diarrhoea.

Do not use sports drinks or high sugar drinks as these can make diarrhoea worse.
Do not use home-made rehydration solutions as they often do not have the right amount of salt or sugar and can be dangerous.

What are the signs of dehydration?

Your child will feel:
- Thirsty
- Restless
- Lethargic or sleepy
- Irritable

You will notice:
- Their mouth is dry
- Their eyes look glassy or slightly sunken
- They cry without tears
- They are making less urine (less than half their normal wet nappies)

What else can I do to help my child get better?

- Do not give medicines at home to reduce the vomiting or diarrhoea. They may be harmful.
- Skin care - Diarrhoea can cause nappy rash. After each bowel motion wash and dry your child's bottom well and then apply a generous layer of protective cream or ointment (e.g. vitamin A ointment or zinc and castor oil cream).

When to bring your child back to the ED?

If your child is:

- Having a lot of diarrhoea (8-10 watery motions or 2-3 large motions per day) or a lot of vomiting and your child is unable to keep fluids down
- There is any blood in the diarrhoea or vomit
- They have severe stomach pains
- Your child shows signs of dehydration
- If you are concerned for any other reason

Danger Signs – When to call an ambulance?

If your child is:

- Very lethargic or sleepy
- Floppy or limp
- Very cold hands and feet
- Pale and sweaty

Dial 111 for an ambulance

Preventing the spread of Gastro

Gastro' spreads very easily to others. You can help prevent spreading the disease by:
- Wash and dry hands thoroughly - especially after using the toilet, after nappy changing and before food preparation.
- Clean the toilet and bathroom areas often and carefully.
- Do not share food and drinks.
- Keep your child away from friends and other children until vomiting and diarrhoea have stopped.
- Children with diarrhoea must stay away from Day Care, Kohanga Reo and School until the diarrhoea has stopped and for 2 days afterwards.

Discharge Checklist.

Before you take your child home we will check that you:

- You feel confident to manage at home
- You know what to expect over the next few days
- You know who to contact if you are concerned
- You know when to bring your child back to the emergency department
- You know the danger signs.

Where to get advice or information?

- Your family doctor
- After hours medical service
- http://www.kidshealth.org.nz/
- Healthline: 0800 611 116
- North Shore Hospital ECC: 486 1491,
- Waitakere Hospital ED: 839 0000

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Taha Whanau
Improving the wellbeing of your child and family
Working Together

Waitemata District Health Board
Best Care for Everyone

Appendix K: Dehydration Scores

Dehydration Scales

Table 5: The WHO Dehydration Scale for Children with Diarrhoea

	A	B	C
LOOK AT: CONDITION a EYES b THIRST	 Well, alert Normal Drinks normally, not thirsty	 Restless, irritable Sunken Thirsty, drinks eagerly	 Lethargic, unconscious Sunken Drinks poorly, or not able to drink
FEEL: SKIN PINCH c	Goes back quickly	Goes back slowly	Goes back very slowly
DECIDE	The patient has **NO SIGNS OF DEHYDRATION**	If the patient has two or more signs in B, there is **SOME DEHYDRATION**	If the patients has two or more signs in C, there is **SEVERE DEHYDRATION**
TREAT	Use Treatment Pan A	Weigh the patient, if possible, and use Treatment Plan B	Weigh the patient and use Treatment Plan C URGENTLY
a Being lethargic and sleepy are *not* the same. A lethargic child is not simply asleep: the child's mental state is dull and the child cannot be fully awakened; the child may appear to be drifting into unconsciousness. b In some infants and children the eyes normally appear somewhat sunken. It is helpful to ask the mother if the child's eyes are normal or more sunken than usual. c The skin pinch is less useful in infants or children with marasmus or kwashiorkor, or obese children.			

From: *The treatment of diarrhoea, a manual for physicians and other senior health workers* (World Health Organization, 2005).

Table 6: The Gorelick Dehydration Scale

Characteristic	No or minimal dehydration	Moderate to severe dehydration
General appearance	*Alert*	*Restless, lethargic, unconscious*
Capillary refill	*Normal*	*Prolonged or minimal*
Tears	*Present*	*Absent*
Mucous membranes	*Moist*	*Dry, very dry*
Eyes	Normal	Sunken; deeply sunken
Breathing	Present	Deep; deep and rapid
Quality of pulses	Normal	Thready; weak or impalpable
Skin elasticity	Instant recoil	Recoil slowly; recoil > 2 s
Heart rate	Normal	Tachycardia
Urine output	Normal	Reduced; not passed in many hours

Scoring: 4 point scale (italics): ≥ 2 Clinical Signs (4 pt) ≥5% BWΔ; ≥ 3 Clinical Signs (4 pt) ≥10% BWΔ; 10 point scale (all signs/symptoms): ≥ 3 Clinical Signs ≥5% BWΔ; ≥ 7 Clinical Signs ≥10% BWΔ

From: Comparing the accuracy of the three popular clinical dehydration scales in children with diarrhea (Pringle et al., 2011)

Table 7: The Clinical Dehydration Scale

Characteristics	0	1	2
General appearance	Normal	Thirsty, restless or lethargic but irritable when touched	Drowsy, limp, cold, or sweaty, +/–comatose
Eyes	Normal	Slightly sunken	Very sunken
Mucous membranes (tongue)	Moist	Sticky	Dry
Tears	Tears	Decreased tears	Absent tears

A score of 0 represents no dehydration; a score of 1 to 4, some dehydration; and a score of 5 to 8, moderate/severe dehydration.
CDS = clinical dehydration scale.

From: External validation of the clinical dehydration scale for children with acute gastroenteritis (Bailey et al., 2010)

Appendix L: Search Strategy

Search Strategy

Table 8: Initial PICo

Theme	Search terms
Population	Child* OR infant OR pediatric OR paediatric AND Gastroenteritis OR diarrh* OR enteritis OR ″viral gastritis″ OR ″gastro-enteritis″
Intervention	Dehydration OR ″volume depletion″ OR hypovol* OR hyponatr* OR hypernatr* OR hyperosmola* OR Rehydrat* OR ″repletion therapy″ OR ″intravenous fluid″ OR ″nasogastric*″ OR isotonic OR hypotonic OR hypertonic OR Ondansetron OR Smectite OR probiotic OR antiemetic*
Context/setting	″ER″ OR ″Emergency Room″ OR ″Emergency Department″ OR ″Accident and Emergency″ OR ″A and E″ OR ″A & E″ OR ED

These terms were combined (with the command <AND>) executed in both MEDLINE/CINAHL and SCOPUS databases and based on the initial results additional terms were added. The initial results also yielded multiple narrative articles so an additional theme relating to the type of article was also created to filter those that were not primary research. A cursory review of the reference list of the initial search also showed that limiting the search to the emergency department eliminated articles that were relevant to the management of gastroenteritis so this theme was deleted.

Proximity searches were devised and executed but these were abandoned as they yielded a higher number of irrelevant articles and after sifting through the first 200 results did not appear to have retrieved any additional articles when compared with a simple thematic search.

The final search was a thematic search as below:

Search executed 26th May 2015 in Medline & Cinahl plus with full text - Results 401 articles

Search executed 17th June 2015 in SCOPUS - Results 431 results

Table 9: Final Matrix of Search Terms

Theme	Search terms
Population	Child* OR infant OR pediatric OR paediatric *AND* Gastroenteritis OR diarrh* OR enteritis OR ″viral gastritis″ OR ″gastro-enteritis″
Intervention	Dehydration OR ″volume depletion″ OR hypovol* OR hyponatr* OR hypernatr* OR hyperosmola* OR hypo-osmola* OR Rehydrat* OR ″repletion therapy″ OR ″intravenous fluid″ OR ″nasogastric*″ OR isotonic OR hypotonic OR hypertonic OR Ondansetron OR Smectite OR probiotic OR lactobacil* OR antiemetic* OR ″anti-emetic*″
Type of Article	RCT OR ″random* control* trial*″ OR review* OR guideline* OR meta-analysis OR consensus OR ″cohort stud*″ OR ″best practice″

Appendix M: Example Appraisal Tools

Table 10: Example Appraisal Tool Devised for Systematic Reviews

Reference	Question Clear	Complete/ relevant Data Set	Inclusion Criteria	Valid Studies, bias Method Rigorous	Low Variance I	Outcome Measures	Results	Comments

Table 11: Example Appraisal Tool Devised for Cohort Studies (treatment)

Reference	Question Clear	Cohort recruitment acceptable	Valid measurement of effect	Clear outcome measures	Confounders identified?	Low BIAS	Outcome measures	Results Treatment effect Confidence	Comments

*NB: Randomised control trial (diagnosis and treatment), cohort studies (treatment) and economic evaluation appraisal tools were devised and used but are **not** included here.*

Included:

- Theme One:
    - Summary of Study Characteristics
    - BCB Interventions Results Table
    - Additional Interventions Results Table
- Theme Three:
    - Summary of Study Characteristics
    - BCB Interventions Results Table
    - Additional Interventions Results Table
- Theme Four:
    - Summary of Study Characteristics
    - BCB Interventions Results Table
    - Additional Interventions Results Table
- Theme Five:
    - Summary of Study Characteristics
    - BCB Interventions Results Table
    - Additional Interventions Results Table
- Theme Six:
    - Summary of Study Characteristics
    - BCB Interventions Results Table
    - Additional Interventions Results Table

Appendix N: Results Tables

Appendix N
Theme One: Assessment of Dehydration - Results Tables

Table 12: Theme One Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Freedman, et al., 2015	Systematic Review	Assessment of hydration	BCB	Canada & US	ED	9 studies, 1039 children	0 to 15years
Bailey et al., 2010	Cohort Study	Clinical dehydration score	Additional	Canada	Tertiary ED	150 children	4 months to 4 years
Enright et al., 2010	Cohort Study	Handheld bladder scanner	Additional	UK	ED	45 children	4 months to 10 years
Falszewska et al., 2014	Systematic Review	Clinical dehydration score	Additional	2 Canada, 1 Rwanda	Hospital	3 studies, 360 children	1 month to 5 years
Kinlin and Freedman, 2012	Cohort Study	Clinical dehydration score	Additional	Canada	Tertiary ED	226 children	>3 months of age
Levy, Waltzman, et al., 2013	RCT (Secondary analysis)	Point of care ketone testing	Additional	USA	Tertiary ED	188 children	6 months to 6 years
Plaisier et al., 2010	Cohort Study	Plasma water measurement	BCB & Additional	The Netherlands	Urban ED	101 children	<2 to 12years
Pruvost et al., 2013	Cohort Study	Body weight	Additional	France	Tertiary ED	293 children	1 month to 2 years

Table 13: Results for BCB Interventions for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measure	Results		Comments	Level of evidence
Correlation between clinical signs and dehydration measured by weight loss							
Plaisier et al., 2010 (CS)	101 children Age <2 - 12years	Urban ED The Netherlands	Correlation between degree of dehydration by weight loss and clinical signs (Two tailed Wilcoxon rank-sum test)	Complete data for 69 participant ↓level of consciousness p<0.05[5], Blood pressure Quality of pulses Heart rate Skin turgor Depth of fontanel Humidity of mucous membranes Depth of eyes Capillary refill time Mental status, Urine output, Thirst	Significant correlation No correlation (actual results not published)	Significant attrition & reporting bias. Percentage weight loss was significantly correlated with ↓level of consciousness. All other clinical signs - no significantly correlation.	Very low
Inter-observer reliability of individual items included in BCB categorical hydration scale							
Kinlin & Freedman 2012 (CS)	226 children	Tertiary ED Canada	Inter-observer reliability for absent tears	*Inter-observer reliability* Weighted k[6] of 0.32 [95% CI 0.18, 0.46]	Fair inter-observer reliability		Very low
Kinlin & Freedman 2012 (CS)	226 children >3 months	Tertiary ED Canada	Inter-observer reliability for sunken eyes	*Inter-observer reliability* Weighted k of 0.40 [95% CI 0.27, 0.51]	Fair inter-observer reliability		Very low

[5] Two tailed Wilcoxon rank-sum test

[6] K or Kappa Score The calculation is based on the difference between how much agreement is actually present ("observed" agreement) compared to how much agreement would be expected to be present by chance alone ("expected" agreement). K <0=less than chance agreement; 0.01-0.2=slight agreement; 0.21-0.4=fair agreement; 0.41-.60=moderate agreement; 0.61-0.80 Substantial greement;0.81-0.99= almost perfect agreement. (Kinlin & Freedman, 2012; Viera & Garrett, 2005).

Study	No of participants	Setting	Outcome Measure	Results			Comments	Level of evidence
Correlation between laboratory measures and dehydration measured by weight loss								
Plaisier et al., 2010 (CS)	101 children Age <2 - 12years	Urban ED The Netherlands	Correlation between degree of dehydration (by weight loss) and laboratory measures (Spearman Correlation)	Complete data for 69 participants			Significant attrition & reporting bias. Blood urea nitrogen, base excess & serum bicarbonate significantly correlated with degree of dehydration. Plasma water did not significantly correlate with the percentage of weight loss	Low
				Blood urea nitrogen	r=0.3, p=0.03[7]	Significant correlation		
				Base excess	r=−0.31, p=0.03	Significant correlation		
				Serum bicarbonate	r=0.32, p=0.02	Significant correlation		
				Plasma water	r=0.21, p=0.98	No correlation		
Use of point of care ketone[8] testing to assess degree of dehydration								
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Correlation between point-of-care serum ketone concentration & dehydration score[9]	Spearman's q = 0.22	p = 0.003	Significant positive relationship	Found a statistically significant relationship between serum ketone concentration and the degree of dehydration by clinical dehydration score	Low
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Correlation between point-of-care serum ketone concentration & serum bicarbonate concentration	Spearman's q = –0.26	p < 0.001	Inversely correlated	Greater correlation between serum ketones and dehydration than for serum bicarbonate.	Low

[7] Spearman rank correlation are valued between 1 and -1 where 1 indicates a perfect association of ranks, zero indicates no association between ranks and -1 indicates a perfect negative association of ranks ("Spearman's Rank-Order Correlation," 2013).
[8] Beta-hydroxybutyrate concentration (mmol/L)
[9] Based on a 10 point prospectively assigned clinical dehydration score.

Study	No of participants	Setting	Outcome Measure	Results			Comments	Level of evidence
Use of point of care ketone[10] testing to assess degree of dehydration *continued*								
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Correlation between serum bicarbonate & dehydration score	Spearman's q = 0.19	p= 0.011	Significant positive relationship	Found a statistically significant relationship between serum bicarbonate concentration and the degree of dehydration by a clinical dehydration score	Low
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Comparison of correlation between ketones & dehydration score versus bicarbonate & dehydration score	Wald $\chi^2_{(1)}$[11] = 5.51	p = 0.019	Correlation between ketones & dehydration score significantly stronger than correlation between bicarbonate & dehydration score		Low
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Correlation between serum ketone with general appearance score	Spearman's q = –0.26	p < 0.001	Significant inverse correlation		Low
Levy, Waltzman, et al., 2013 Secondary analysis of RCT	N=188 6 months to 6 years of age	ED Urban, academic, tertiary care hospital USA	Correlation between serum ketone with serum glucose concentration	Spearman's q = –0.74	p < 0.001	Significant inverse correlation		Low

[10] Beta-hydroxybutyrate concentration (mmol/L)
[11] Wald test – used to test the null hypothesis that the relative risk of "disease" associated with this variable is unity or whether the variable of interest is related to the outcome of disease.

Appendix N

Theme One: Results for Additional Interventions Identified from the Literature for Assessment of Dehydration

Table 14: Results for Additional Interventions for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measures	Results			Comments	Level of evidence
Clinical Dehydration Score (CDS) accuracy								
Falszewska et al., 2014 (SR)	3 studies 360 children 1 month-5 years of age	2 Canada 1 Rwanda	Accuracy of CDS for predicting <3%, 3-6% & >6% dehydration	2 studies in high income countries only:			In high income settings the CDS was found to be useful at ruling in >6% dehydration but has limited accuracy for ruling it out or for ruling in or out lower degrees of dehydration.	Low
					LR+[12]	**LR-**		
				<3% dehydration	1.21-2.2	0.63-0.79		
				3-6% dehydration	1.3-1.66	0.67-0.9		
				>6% dehydration	5.2-6.59	0.4-0.55		
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA ED	Accuracy of CDS for predicting <3%, 3-6%, ≥5% & >6% dehydration	3 studies included (137 children)			All Cohort studies no RCTS Some diagnostic accuracy ruling dehydration in but this is more evident at higher degrees of dehydration.	Low
					LR+	**LR-**		
				<3% dehydration	1.64-2.19	0.79 -0.84		
				3-6% dehydration	1.15-1.21	0.66-0.79		
				≥5% dehydration	1.87	0.30		
				>6% dehydration	5.19-11.79	0.55-0.71		
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA ED	Accuracy of CDS for predicting <3%, 3-6%, ≥5% & >6% dehydration		**Sensitivity**	**Specificity**	All Cohort studies no RCTS Some diagnostic accuracy ruling dehydration in but this is more evident at higher degrees of dehydration.	Low
				<3% dehydration	0.32 -0.33	0.80-0.85		
				3-6% dehydration	0.67 -0.75	0.38-0.42		
				≥5% dehydration	0.83	0.55		
				>6% dehydration	0.31-0.50	0.0.90-0.97		
Clinical Dehydration Score (CDS) and inter-observer reliability								
Kinlin & Freedman 2012 (CS)	226 children Older than 3 months of age	Canada	Inter-observer reliability	*Inter-observer reliability* Weighted k[13] of 0.52 [95% CI 0.41, 0.63]			CDS had moderate inter-observer reliability but had no correlation with percentage weight gain.	Very low

[12] Likelihood ration Interpretation - >10=large/conclusive increase in likelihood of disease; 5-10=moderate increase in likelihood of disease;2-5=small increase in likelihood of disease; 1-2=minimal increase in likelihood of disease; 1= no change in the likelihood of disease; 0.5-1=minimal decrease in likelihood of disease;.2-0.5= decrease in likelihood of disease; 0.1-0.2=moderate decrease in likelihood of disease; <0.2=Large and often conclusive decrease in likelihood of disease.

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ults for Additional Interventions Identified from the Literature for Assessment of Dehydration

Outcome Measures		Results		Comments	Level of evidence
core (CDS) Score					
Association between the CDS for children and the LOS in the ED after being seen by physician	No dehydration Some dehydration Mod/severe dehydration	**Length of Stay in minutes (IQR)** 54 (26–175) 128 (25–334) 425 (218–673) P<0.001		Suggests CDS is a good predictor of length of stay.	Low
ith weight gain, no of diarrhoea episodes, serum bicarbonate, serum pH, LOS and discharge confidence					
Correlation of CDS with other parameters,	Weight gain		No correlation	Participants all failed ORT and received IVF. No Nasogastric rescue was attempted.	Very low
	N of diarrhoea episodes Serum bicarbonate PH Length of stay Physician willingness to discharge 2 hours.		Modest correlation	CDS reduced with treatment but has limited use for identifying children who require IVF.	
CDS>5% as a predictor for hospital admission		**LR+ [95% CI]** 1.8 (1.3-2.4)	**LR-[95% CI]** 0.59 (0.41, 0.84).		Very low

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Theme One: Results for Additional Interventions Identified from the Literature for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measures	Results			Comments	Level of evidence
Accuracy of Gorelick Hydration Score								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA	Accuracy of 4 and 10 point scale for diagnosing ≥5% & ≥10% dehydration	2 Studies included (n=299)	**LR+**	**LR-**	Overall accuracy of this score was found to be between 57.52 and 86.56. Little difference between four and ten point scale.	Low
				4 point scale				
				≥5% dehydration	6.25	0.45		
				≥10% dehydration	4.85	0.22		
				10 point scale				
				≥5% dehydration	1.68-4.88	0.15 – 0.45		
				≥10% dehydration	6.23	0.21		
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA	Accuracy of 4 and 10 point scale for diagnosing ≥5% & ≥10% dehydration		**Sensitivity [95% CI]**	**Specificity [95% CI]**	Overall accuracy of this score was found to be between 57.52 and 86.56. Little difference between four and ten point scale.	Low
				4 point scale				
				≥5% dehydration	0.79 (0.67-0.89)	0.87 (0.80-0.93)		
				≥10% dehydration	0.82 (0.48-0.98)	0.83 (0.77-0.88)		
				10 point scale				
				≥5% dehydration	0.75-0.87	0.55-0.82		
				≥10% dehydration	0.82 (0.48-0.98)	0.87 (0.81-0.91)		
Accuracy of World Health Organization Scale								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA	Accuracy of WHO to predict >5% dehydration	1 Study included (n=113)			Overall accuracy 77.88	Low
				4 item scale for diagnosing ≥5% dehydration	**LR+:** 1.58	**LR-:** 0.89		
					Sensitivity [95% CI]	**Specificity [95% CI]**		
					0.25 (0.05-0.57)	0.84 (0.76-0.91)		

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Theme One: Results for Additional Interventions Identified from the Literature for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measures	Results			Comments	Level of evidence
Accuracy of physician assessment of hydration								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada & USA	Accuracy of Physician assessment to predict degrees of dehydration	4 studies included (n=466)			Large variance in methodological approaches and samples	Very low
					LR+	**LR-**		
				<5% dehydration	2.48	0.37		
				6-10% dehydration	1.00- 2.03	0.28-0.89		
				≥10% dehydration	4.34	0.35		
					Sensitivity	**Specificity**		
				<5% dehydration	0.74	0.70		
				6-10% dehydration	0.33-1.00	0.84		
				≥10% dehydration	0.71	0.84		
Bedside ultrasound (inferior Vena Cava (IVC)/Aorta (Ao) ratio for diagnosing degree of dehydration								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	USA	Accuracy of IVC/Ao ratio <0.80 to predict >5% dehydration	1 study included (n=71)			Likely to over diagnose >5% dehydration	Very low
					LR+:1.95	**LR-:**0.27		
				IVC/Ao ratio <0.80	**Sensitivity [95% CI]** 0.85 (0.68-0.95)	**Specificity [95% CI]** 0.56 (0.40-0.72)		
Digital Capillary Refill Time (DCRT) for diagnosing degree of dehydration								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	Canada	Accuracy of DCRT ≥4 secs to predict >5% dehydration	1 study included (n=83)			Encouraging result, requires further study	Very low
					LR+: 11.67	**LR-:** 0		
				DCRT ≥4 secs	**Sensitivity [95% CI]** 1.00 (0.75-1.00)	**Specificity [95% CI]** 0.91 (0.82-0.97)		

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Theme One: Results for Additional Interventions Identified from the Literature for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measures	Results			Comments	Level of evidence
Urinalysis for diagnosing degree of dehydration								
Freedman et al., 2015 (SR)	9 studies, 1039 participants	USA	Accuracy of Urine Specific Gravity, 1.030 to predict 3% dehydration	1 study included (n=75) Urine Specific Gravity, 1.030	**LR+:** 1.07 **Sensitivity [95% CI]** 0.64 (0.49-0.77)	**LR-:** 0.9 **Specificity [95% CI]** 0.40 (0.21-0.61)	Little diagnostic value of urine specific gravity or ketones for predicting degree of dehydration.	Very low
Freedman et al., 2015 (SR)	9 studies, 1039 participants	USA	Accuracy of Urine Ketones, 1.030 to predict 5% dehydration	Urine Ketones, 1.030	**LR+:** 0.54 **Sensitivity [95% CI]** 0.38 (0.15-0.65)	**LR-:** 2.05 **Specificity [95% CI]** 0.31 (0.19-0.44)	Treatment weight compared with pre & post treatment weight	
Bedside bladder scan for diagnosing degree of dehydration								
Enright el al., 2010 (CS)	45 children	ED setting UK	Urine production (ml/kg/hr)	*Outcome* Admitted vs discharged Mild vs moderate/severe dehydration Received IVF vs no IVF	*mL/kg/hr* 2.361.5 vs 1.861.5 2.361.5 vs 0.660.7 0.460.46 vs 1.961.6	*P value* 0.01 0.0011 0.001	Standard was WHO dehydration scale. Statistically significantly less urine produced by children with more severe markers of disease. Requires 2 measurements to calculate mL/kg/hr so limited practical value for initial assessment.	Very low

Appendix N

Theme One: Results for Additional Interventions Identified from the Literature for Assessment of Dehydration

Study	No of participants	Setting	Outcome Measures	Results	Comments	Level of evidence
Body weight as a measure of dehydration						
Pruvost et al., 2013	293 children age 1 month to 2 years	France Tertiary ED	Correlation between post illness weight[14] and theoretical[15] weight	(n=111) Pearson coefficient 0.978 Regression coefficient 0.99 [95% CI 0.95-1.04) Mean post illness weight 8.88kg+/-1.87 SD Mean theoretical weight 9.26kg +/-1.91 SD Post illness weight underestimated theoretical weight.by 0.48kg [95%CI 0.06-0.79]	Excellent correlation between theoretical and measured post illness weight.	Very low
Pruvost et al., 2013	293 children age 1 month to 2 years	France Tertiary ED	Correlation between pre-illness[16] weight and post illness weight	(n=51) Pearson coefficient 0.979 (p<0.0001) Post illness weight underestimated pre-illness weight by 0.19kg [95% CI 0.03-0.36]	Excellent correlation between pre and post illness weight.	Very low
Pruvost et al., 2013	293 children age 1 month to 2 years	France Tertiary ED	Correlation between actual and theoretical pre-illness weight	(n=37) Pearson coefficient 0.985 Theoretical pre-illness weight underestimated actual pre-illness weight by 0.21kg [95% CI 0.08-0.34], P=0.002	Excellent correlation between actual and theoretical pre illness weight.	Very low
Pruvost et al., 2013	293 children age 1 month to 2 years	France Tertiary ED	Concordance between 5% dehydration (by post illness weight), theoretic weight, pre-illness weight & clinical assessment.	Mean difference in fluid deficit based on post illness weight from that calculated based on theoretical weight was 4.0% Prevalence of 5% dehydration based on post illness weight was 21% (P<0.001) Prevalence of 5% dehydration based on theoretical weight was 60%(P<0.001) Prevalence of 5% dehydration based on clinical assessment was 66% (p<0.001)	Post illness weight underestimated prevalence of dehydration >5% (difference of 4%). Better agreement between theoretical weight & clinical assessment & detection of 5% dehydration.	Very low

[14] Defined as first weight with less than 1% difference on consecutive days – weighed daily for days post discharge
[15] Extrapolated from growth charts with at least 3 entries and if they did not cross centile lines
[16] Measured within 8 days of illness, when there were no symptoms, naked or near naked and on electronic scales – NOT standardised.

Table 15: Theme Two Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Dalby-Payne & Elliott, 2011	Systematic Review	Enteral vs IV rehydration	BCB	Multiple [17]	ED & Community	42 SR or RCTS	1 month to 12 years
Hartling et al., 2009	Systematic Review	Oral vs IV rehydration	BCB	Multiple [18]	See footnote	17 RCTS, 1811 participants	<18 years
Freedman, Thull-Freedman, et al., 2013	Cohort Study	Revisits	BCB	Canada	ED	3346 visits	<18 years
Mace et al., 2013	Economic Evaluation	Subcutaneous rehydration	Additional	USA	ED/urgent care	148 participants	0.2–9.8 years
Spandorfer et al., 2012	RCT	Subcutaneous rehydration	Additional	USA	ED/urgent care	148 participants	0.2–9.8 years

Table 16: Results for BCB Interventions for the Route of Rehydration

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of Enteral versus IV Rehydration								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of Diarrhoea	**Study** 1 (RCT 9, n=946) 2 (RCT 2, n=494) 3 (RCT 5, n=415) 4 (RCT 8, n=960)	**WMD[19] (hours)** –6.39 hours –17.77 hours +1.76 hours –5.90 hours	**95% CI (hours)** –13.73 to +0.94 –27.55 to –7.99 –0.91 to +4.42 –12.70 to +0.89	It is not clear whether enteral rehydration is more effective than IV rehydration at reducing duration of diarrhoea.	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Duration of Diarrhoea	*8 RCTs, n=960* WMD -5.90 hours [95% CI -12.70 to 0.89] I^2 76.3%			No statistical difference between groups	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Length of stay	**Study** 1 (RCT 3, n=161) 2 (RCT 6, n=526)	**WMD (days)** –0.88 –1.2	**95% CI (days)** –1.45 to –0.32 –2.38 days to –0.02	Enteral rehydration associated with reduced duration of hospital stay	Very low

[17] Developed and developing actual countries not stated
[18] USA, Canada, Australia, Finland, Puerto Rico, Egypt, Mexico, Iran, Afghanistan, Colombia, Peru, Panama
[19] WMD= weighted mean difference

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Enteral versus IV Rehydration *continued*						
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple[20]	Length of Stay	*6 RCTs, n=526* WMD 1.20 days, [95% CI -2.38 to -0.02] I^2 95.1%	Children treated with ORT spent less time in hospital but this was no longer significant when one outlying study was removed from the analysis	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Weight gain	**Study** / **WMD (g)** / **95% CI (g)** 1 (RCT 5, n=276) / –26 / –60.8 to +9.7 2 (RCT 6, n=526) / –26.33 / –206.92 to +154.26	It is not clear whether enteral rehydration is more effective than IV rehydration at improving weight gain.	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Weight gain	*6 Studies, n= 369* **WMD -**26.33 g, [95% CI -206.92 to 154.26**]** (I^2 90.8%).	No significant difference in weight gain between the two groups. Significant heterogeneity	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Risk of Hyponatraemia	*2 RCTS, n=248* RD 1%, [95% CI -13 to 15 I^2 67.2%	No statistical difference between groups.	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Risk of Hypernatraemia	*10 RCTs, n=* 1062 RD 0%, [95% CI -1 to 1] I^2 0%	No statistical difference between groups. Significant heterogeneity	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Total fluid intake at 6 hours	*8 RCTS, n=985* WMD 32.09 mL/kg, 95% [95% CI -26.69 to 90.88) I^2 99.9	No statistical difference between groups. Significant heterogeneity	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Total fluid intake at 24 hours	*7 RCTS, n=835* 73.45 mL/kg, [95% CI -31.78 to 178.69] I^2 99.8%	No statistical difference between groups	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Death or seizure as a result of treatment	**Study** / **95% CI** 1 (RCT 16, n=1545) / RR 0.36 / 0.14 to 0.89	IV rehydration is associated with an increased risk of adverse events.	Very low

[20] USA, Canada, Australia, Finland, Puerto Rico, Egypt, Mexico, Iran, Afghanistan, Colombia, Peru, Panama

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Enteral versus IV Rehydration *continued*						
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Adverse events Paralytic Ileus	*2 RCTS, n=670 – fixed effect analysis* RD 3%, [95%CI 1 to 5] IVT risk 0%; I^2 43.8% *Random effect analysis* RD 2%, [95% CI 0 to 5] NNT =33 [95% CI 20 to 100]	There were statistically significantly more children with paralytic ileus in the ORT group (fixed-effect model) but not when random effects model was used.	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Adverse events phlebitis	*5 RCTS, n=877* RD -2%, [95% CI -4 to -1] *I*2 0% NNT = 50 [95% CI 25 to 100]	The occurrence of phlebitis in the IVT group was statistically significant	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Adverse events peri-orbital oedema, seizures, and abdominal distention	No statistically significantly different between groups		Very low
Freedman, Thull-Freedman, et al., 2013 (CS)	3346 visits	Canada ED	Risk of revisit	OR 1.76; [95% CI 1.36–2.26]	IV fluids increased likelihood of revisits regardless of severity of illness.	Very low
Hartling et al., 2009 (SR)	17 RCTS, 1811 participants	Multiple	Failure to rehydrate IVF versus ORT	*One study excluded from analysis (outlier)* Risk Difference 2%, [95%CI 0.08 to 5] NNT 50, [95% CI 20 to 125] I2 43.0%	Smaller risk of rehydration failure with IVF than for ORT.	Very low

Table 17: Results for Additional Interventions for Route of Rehydration

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Subcutaneous versus IV Rehydration						
Spandorfer et al., 2012 (RCT)	148	USA ED	Mean total volume infused (ED & inpatient)	rHFSC 365.0 (324.6)mL over 3.1hours IV 455.8 (597.4)mL over 6.6hours *P*< 0.51	rHFSC was inferior to IVF but reflects that most children who were admitted were switched to IVF due to lack of confidence with SC lines.	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Mean total volume infused (ED only)	rHFSC 334.3(226.40)mL IV 299.6(252.33)mL *P* < 0.03	rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Mean (SD) reduction is dehydration scores	rHFSC.6 (1.26) IV 2.2(1.64) *P* < 0.07	No significant difference between groups, rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Mean (SD) percent weight increase from baseline to post-infusion	rHFSC 2.9 %(2.52%) IV 3.8 %(15.17%) *P* < 0.62	No significant difference between groups, rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Successful catheter placement	rHFSC 100% IV 78.7% *P* < 0.0001 All IV failures occurred in patients <3 years	rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Rated s "easy to administer" by medical staff	rHFSC 95.5% IV 65.3% *P* < 0.001	rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Proportion of parents "satisfied" or "very satisfied"	rHFSC 94.5% IV 73.3%	rHFSC was NOT inferior to IVF	Very low
Spandorfer et al., 2012 (RCT)	148	USA ED	Infusion site pain	**Mild**: rHFSC, 61.6% IV, 66.7% **Moderate** rHFSC, 15.1% IV, 12.0%	FLACC scores after catheter placement and at end of infusion were similar.	rHFSC was NOT inferior to IVF

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Subcutaneous versus IV Rehydration *continued*						
Spandorfer et al., 2012 (RCT)	148	USA ED	Infusion site reaction	**Infusion-site erythema** rHFSC, 74.0%; IV, 25.3% **Swelling** rHFSC, 80.8%; IV, 21.3% **Oedema** rHFSC, 6.8%; IV, 1.3%	rHFSC was inferior to IVF All reactions graded as mild to moderate& resolved with no treatment.	Very low
Mace et al., 2013 (EE)	Based on study by Spandorfer et al N=148	USA ED	Success of treatment	rHFSC 93% IV 76%	rHFSC was NOT inferior to IVF Difference in effectiveness was due to difficulties obtaining IV access.	Very low
Cost Effectiveness of Subcutaneous versus IV Rehydration						
Mace et al., 2013 (EE)	Based on study by Spandorfer et al N=148	USA ED	Relative cost of SC versus IV fluids	rHFSC fluids $722 IVF $889	Difference in the cost primarily due to the shorter LOS for rHFSC fluids versus IV fluids. Savings most apparent in patients <3 years of age.	Very low

Appendix N
Theme Three: Volume/Rate of Rehydration - Results Tables

Table 18: Theme Three Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Freedman, Parkin, et al., 2011	RCT	Rapid Vs Standard IV rehydration	BCB	Canada	ED	226 participants	3 months to 11 years
Molina, et al., 2015	Cohort Study	Rapid Vs Standard IV rehydration	BCB	Spain	Outpatient	83 participants	6 months to 16 years
Nager & Wang, 2010	RCT	Ultra-rapid and rapid IV rehydration	BCB	USA	ED	88 participants	3 to 36 months
Powell et al., 2011	RCT	Rapid Vs standard IV rehydration	BCB	Australia	ED	254 participants	6 to 72 months
Waddell et al., 2014	Cohort Study	Rapid rehydration	BCB	Australia	ED	235 children	6 months to 4 years

Table 19: Results for BCB Interventions for Volume/Rate of Rehydration

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of ultra rapid (50ml/kg) for 1 hour versus rapid (50ml/kg) over 3 hours IV rehydration (0.9% Sodium Chloride)						
Nager and Wang 2010 (RCT)	88 children	USA ED	Average weight gain	Ultra-rapid 4.2% Rapid 3.8% P =0.343	No significant difference Attrition bias –admitted patients were excluded from analysis (4%).	Very low
Nager and Wang 2010 (RCT)	88 children	USA ED	Heart rate decrease	Ultra-rapid 25 Rapid 31 P = 0.163.	No significant difference	Very low
Nager and Wang 2010 (RCT)	88 children	USA ED	Mean emesis volume	Ultra-rapid 69 mL/hr Rapid 21 mL/hr (for 3 hours).	Unclear clinical significance given different duration of rehydration.	Very low

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of ultra rapid (50mL/kg) for 1 hour versus rapid (50mL/kg) over 3 hours IV rehydration (0.9% Sodium Chloride) *continued*						
Nager and Wang 2010 (RCT)	88 children	USA ED	Mean urine volume	Ultra 93 mL/hr Rapid 24 mL/hr for 3 hours	Unclear clinical significance given different duration of rehydration.	Very low
Nager and Wang 2010 (RCT)	88 children	USA ED	Stool output	Ultra-rapid 45 mL/hr Rapid 25 mL/hr P = .042	Unclear clinical significance given different duration of rehydration.	Very low
Nager and Wang 2010 (RCT)	88 children	USA ED	Revisits	Ultra-rapid 15.6% Rapid 14.0% (95%CI, 6.5%-29.5%) P = 0.999.	No significant difference	Very low
Efficacy of rapid (25mL/kg for 4 hours) versus standard NG rehydration (24hr volume (first 6 hours to replace 5% deficit, residual volume over 18 hours + losses)						
Powell et al., 2011 (RCT)	228 children	Australia ED	>2% weight loss during rehydration	Rapid 11.8% [95% CI: 6.0%–17.6%] Slow 9.2% [95% CI: 3.7%–14.7] Difference of 2.6% in favour of slow $\chi^2 = 0.405$; $P = 0.52$	No significant difference CIs were too wide for reliable assessment due to under recruitment	Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	Overall secondary treatment failure	Rapid 30.3% [95% CI: 22.5–38.8] Slow 44.0% [95% CI: 34.6–53.4] P =0.03	Favours rapid rehydration	Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	Inability to tolerate the insertion of a nasogastric tube	Rapid 1/119 Slow 2/109 P=0.51	No significant difference	Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	Frequent or persistent vomiting	Rapid 6/119 Slow 3/109 $P = 0.38$	No significant difference	Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	IVF requirement	Rapid 5.9% [95% CI: 2.9%–11.7%] Slow 4.9% [95% CI: 2.0%–10.3%]) $\chi^2 = 0.191$; $P = 0.66$	No significant difference	Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	Moderate dehydration (>3 clinical signs at 4-6 hours)	Rapid 11.8% Slow 22.9% No P value calculated.		Very low
Powell et al., 2011 (RCT)	228 children	Australia ED	Revisits	7.6% of rapid group represented within 24 hours	Given that 100% of standard group were admitted this is lower overall	Very low

Table 20: Results for Additional Interventions for Volume/Rate of Rehydration

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of rapid (60mL/kg) versus standard (20mL/kg) IV rehydration (0.9% Sodium Chloride) over one hour						
Freedman, Parkin, et al., 2011 (RCT)	226 children	Canada ED	Participants rehydrated at 2 hours[21]	Rapid (41/114 (36%) versus Standard 33/112 (30%) Difference 6.5% [95% CI 5.7% to 18.7%] P=0.32	No significant difference Results did not change after adjustment for weight, baseline dehydration score, and baseline pH	Low
Freedman, Parkin, et al., 2011 (RCT)	226 children	Canada ED	Proportion of children requiring prolonged treatment	Rapid 52% versus standard 43% Difference 8.9%, [95% CI 21% to −5%] P=0.19		Low
Freedman, Parkin, et al., 2011 (RCT)	226 children	Canada ED	Median time to discharge	Rapid 6.3 versus standard 5.0 hours P=0.03	Unclear clinical relevance	Low
Observed effects of 2 hours of 20mL/kg IV rehydration with 0.9% Sodium Chloride & 2.5% Dextrose						
Janet et al., 2015 (CS)	83 children	Spain Outpatient	Admission rates	16,8% (n=14) 9 persistent vomiting 5 poor appearance	No control	Very low
Janet et al., 2015 (CS)	83 children	Spain Outpatient	Revisits <48 hours	7.2% (n=5)		Very low
Janet et al., 2015 (CS)	83 children	Spain Outpatient	Serum ketone level	Mmol/L (IQR) Before 1.5 (0.6-4.0) After 0.8 (0.2-2.8) P <0.001	Statistically significant difference. No significant changes observed in sodium, chloride, potassium and osmolality values	Very low
Janet et al., 2015 (CS)	83 children	Spain Outpatient	Serum urea level	Mg/dL (IQR) Before 34.4 (31.3-37.4) After 27.3 (23.6-31) P<0.001	Statistically significant difference.	Very low
Janet et al., 2015 (CS)	83 children	Spain Outpatient	Gorelick dehydration score	Before 3 (2-4) After 0 (0-1) P <0.001	Statistically significant difference.	Very low

[21] Based on clinical dehydration score

Appendix N
Theme Three: Additional Interventions for Volume/Rate of Rehydration

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Impact of a rapid rehydration pathway on ED patient outcomes						
Waddell et al., 2014 (CS)	235 children	Australia ED	Given oral fluids	Pre-test group 47.5%) Post-test group 54.7% Overall increase 7.2% $\chi^2 = 1.233$ P= 0.164	No significant difference	Very low
Waddell et al., 2014 (CS)	235 children	Australia ED	Received nasogastric fluids	Pre-test group 5.1% Post-test group 8.5% $\chi^2 = 1.110$ P = 0.214	No significant difference	Very low
Waddell et al., 2014 (CS)	235 children	Australia ED	Median LOS	Pre-test group 2.86 (IQR = 1.13–3.43) Post-test group 3.76, (IQR = 1.43–4.63) longer median ED U = 5867, P = 0.047	May have been affected by 11% increase in patient volume and higher triage scores for the post-test group suggesting greater severity of illness.	Very low

Appendix N
Theme Four: Type of Rehydration Fluid - Results Tables

Table 21: Theme Four Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Hanna & Saberi, 2010	Cohort Study	Hyponatraemia	BCB	USA	Inpatient	124 participants	1 month to 12 years
Levy, Bachur, et al., 2013	RCT	IV Dextrose	BCB	USA	ED	188 participants	6 months to 6 years
Passariello et al., 2015	RCT	Oral rehydration gel	Additional	Italy	ED	83 participants	5 to 36 months
Passariello et al., 2011	RCT	Oral rehydration fluid with zinc	Additional	Italy	ED	119 participants	3 to 36 months

Table 22: Results for BCB Interventions for Type of Rehydration Fluid

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Adverse effects of hypotonic IV maintenance fluid						
Hanna and Seberi 2010 (CS)	124 children	USA Inpatient	Increase in incidence of hyponatraemia	97 children were isonatraemic prior to fluid administration and 18 (18.5%) developed hyponatraemia (P<0.34)	Not statistically significant but clinically significant	Very low
Efficacy of IV bolus of 20mL/kg of 0.9% Sodium Chloride with 5% Dextrose(NSD5) versus 0.9% Sodium Chloride (NS) in children with gastroenteritis						
Levy, Bachur, et al., 2013 (RCT)	188 children	USA ED	Need for admission	NSD5 35% NS 44% Risk difference 9% [95% CI -5% to 22%]	Favours NSD5	Low

Study	No of participants	Setting	Outcome measures	Results		Comments	Level of evidence
Efficacy of IV bolus of 20mL/kg of 0.9% Sodium Chloride with 5% Dextrose(NSD5) versus 0.9% Sodium Chloride (NS) in children with gastroenteritis *continued*							
Levy, Bachur, et al., 2013 (RCT)	188 children	USA ED	Mean change (Δ) in serum ketone concentration over time[22]	**At 1 hour** NSD5 Δ1.2 Mmol/L NS Δ 0.1 Mmol/L Mean difference 1.1mmol/L 95% CI 0.4 to 1.9 Mmol/L	**At 2 hours** NSD5 Δ1.9 Mmol/L NS Δ 0.3 Mmol/L Mean difference 1.6mmol/L 95% CI 0.9 to 2.3 Mmol/L	Favours NSD5	Low
Levy, Bachur, et al., 2013 (RCT)	188 children	USA ED	Revisit rate	N =114 (discharged from ED) NSD5 17% NS 24% Risk difference 7% [95% CI -9% to 23%]		Favours NSD5	Low
Levy, Bachur, et al., 2013 (RCT)	188 children	USA ED	Admission rate in children with initial abnormal serum bicarbonate levels (HCO3 <20 Mmol/L)	N=123 NSD5 46% NS 53% Risk difference 7% [95% CI -10% to 25%]		Favours NSD5	Low
Levy, Bachur, et al., 2013 (RCT)	188 children	USA ED	Revisit rate in children with initial abnormal serum bicarbonate levels	N=55 (discharged from ED) NSD5 11% NS 30% Risk difference 19% [95% CI -2% to 40%]		Favours NSD5	Low

[22] calculated as the initial serum ketone value minus the 1- and 2-hour ketone values

Table 23: Results for Additional Interventions for Type of Rehydration Fluid

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Standard ORS versus Gel ORS plus zinc in children with gastroenteritis						
Passariello et al., 2015 (RCT)	83	Italy ED	Amount of ORS consumed at 4 hours	Standard ORS 8mL/kg ORS Gel plus zinc 19mL/kg P<0.001	Favours ORS gel plus zinc. No patient required hospitalization. No adverse events were observed in either of the two study groups.	Low
Passariello et al., 2015 (RCT)	83	Italy ED	Amount of ORS consumed at 24 hours	Standard ORS 11mL/kg ORS Gel plus zinc 30mL/kg P<0.001	Favours ORS gel plus zinc Vanilla pudding consistency more palatable than banana flavoured ORS	Low
Passariello et al., 2015 (RCT)	83	Italy ED	Number of children who refused ORS (<10mL/kg/day)	Standard ORS 30% ORS Gel plus zinc 2.3% P=0.001	Favours ORS gel plus zinc	Low
Passariello et al., 2015 (RCT)	83	Italy ED	Diarrhoea at 72 hours	Standard ORS 72.5% ORS Gel plus zinc 48.8% P= 0.028	Favours ORS gel plus zinc	Low
Passariello et al., 2015 (RCT)	83	Italy ED	Mean duration of diarrhoea	Standard ORS 116.0 ± 40.7 hrs ORS Gel plus zinc 93.2 ± 38.8 hrs P =0.001	Favours ORS gel plus zinc	Low
Efficacy of Standard ORS versus Super ORS containing prebiotics plus zinc in children with gastroenteritis						
Passariello et al., 2015 (RCT)	119	Italy ED	Resolution of diarrhoea at 72hours	Standard ORS 50% Super ORS 72.9% P = 0.01	Favours Super ORS No adverse events related to the use of the ORS were observed in either groups	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Number of stools in 24hrs	Standard ORS 4.5; [95% CI 3.89-5.11] Super ORS 5.9; 95% [CI, 5.28-6.63] P =0.002	Favours Super ORS	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Number of stools in 48hrs	Standard ORS 4.06 [95% CI 3.46-4.66] Super ORS 5.11 [95% CI, 4.29-5.94] P =0.037	Favours Super ORS	Very low

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Standard ORS versus Super ORS containing prebiotics plus zinc in children with gastroenteritis *continued*						
Passariello et al., 2015 (RCT)	119	Italy ED	Number of stools in 72hrs	Standard ORS 2.88 [95% CI 2.44-3.32] Super ORS 3.89 [95% CI 3.13-4.65] P =0.02	Favours Super ORS	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Total consumption of ORS	Standard ORS 22 mL/kg [95% CI 17-29] Super ORS 50 mL/Kg; [95% CI, 41-59] P < 0.001)	Favours Super ORS	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Number of missed working days	Standard ORS 1.45; [95% CI, 1.02-1.88] Super ORS 0.39; [95% CI, 0.08-0.70] P < 0.001	Favours Super ORS	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Hospitalisation rate	Standard ORS 5% Super ORS 1.7%	No significant difference	Very low
Passariello et al., 2015 (RCT)	119	Italy ED	Requirement for adjunct therapy after 72 hours	Standard ORS 32% Super ORS 10% P = 0004	Favours Super ORS	Very low

Appendix N
Theme Five: Adjunct Therapies – Results Tables

Table 24: Theme Five Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Carter & Fedorowicz, 2012	Systematic Review	Antiemetic therapy	BCB	Venezuela, USA, Germany, Turkey	ED	10 trials (1479 children)	5 months to 12 years
Dalby-Payne & Elliott, 2011	Systematic Review	Gastroenteritis interventions	BCB and Additional	Multiple [23]	ED & Community	42 SR or RCTS	1 month to 12 years
Freedman, Hall, et al., 2014	RCT	Ondansetron	BCB	Canada	ED	215 children	6 months to 10 years
Freedman, Powell, et al., 2010	Cohort Study	Ondansetron	BCB	Canada	US	105 children	6 months to 8.2 years
Hervás, et al., 2012	Cohort Study	Ondansetron	BCB	Spain	ED	1871 children	0 to 14 years
Freedman et al., 2012	Cohort Study	Ondansetron	BCB	Canada	ED	3508 visits	6 months to 10 years
Sturmet al., 2010	Retrospective review	Ondansetron	BCB	USA	ED	34117 children	3 months to 18 years
Gouin et al., 2012	RCT	Dimenhydrinate	Additional	USA	ED	144 children	1 to 12 years
Kita et al., 2015	RCT	Domperidone	Additional	Japan	ED and GP practice	56 children	6 months to 6 years
Lehert et al., 2011	Systematic Review	Racecadotril	Additional	France, Peru, India, Spain, Guatamale, Mexico	Inpatient and outpatient	9 RCTS, 1384 children	Median Age 12 months
Rautenberg et al., 2012	Economic Evaluation	Racecadotril	Additional	UK	Primary care	N/A	<5 years
Allen, et al., 2010	Systematic Review	Probiotics	Additional	Multiple [24]	ED & Community	56 studies 8014 children	Adults and children

[23] Developed and developing actual countries not stated
[24] Developed and developing actual countries not stated

Appendix N
Theme Five: Adjunct Therapies – Results Tables

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Dinleyici et al., 2012	Systematic Review	Probiotics	Additional	Multiple [25]	ED & Community	19 studies, 1128 children	
Freedman, Shurman, et al., 2015	RCT	Probiotics	Additional	Canada	ED	123 children	4 to 48 months
Pieścik-Lech et al., 2013	RCT	Probiotics	Additional	Poland	Hospital	88 children	4 to 60 months
Szajewska, Ruszczynski, et al., 2014	Systematic Review	Probiotics	Additional	France, Ecuador, Peru, Thailand	3 inpatient, 1 OPD	4 studies 304 children	1 to 48 months
Szajewska et al., 2013	Systematic Review	Probiotics	Additional	Multiple countries mostly European	Inpatient and outpatient	15 studies, 2963 children	3 to 60 months
Szajewska, Urbanska, et al., 2014	Systematic Review	Probiotics	Additional	Finland, Italy, Turkey, Korea	Inpatient	5 RCTS, 352 children	3 to 60 months

[25] Developed and developing actual countries not stated

Table 25: Results for BCB Interventions for Adjunct Therapies

Study	No of participants	Setting	Outcome measures	Results				Comments	Level of evidence
Efficacy of Ondansetron versus placebo for cessation of vomiting (oral administration[26])									
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Proportion of children with cessation of vomiting (<24hours)	*3 studies included*[27] RR[28] = 1.33 [95% CI 1.19-1.49] p<0.001; 1^2 =0% OR of 4.33 [95% CI 2.11 to 10.11] p<0.01				Oral Ondansetron increases the risk of cessation of vomiting and reduces the risk for requirement of IVF; it also reduces the risk of admission. The odds of the cessation of vomiting were over four times more likely with Ondansetron versus placebo	Low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Proportion of children ***with*** episodes of vomiting, <24 hours after treatment	**Study** 1 (RCT 1, n=36) 2 (RCT 1, n=145) 3 (RCT 1, n=215) 4 (RCT 1, n=109) 5 (RCT 2, n=144)	**Ondansetron** 42% 42% 14% 22% 58%	**Placebo** 83% 46% 35% 67% 47%	 p=0.04 p=0.8 p<0.001 p<0.001 p=21		
Freedman, Hall, et al., 2014 (RCT)	215 children	Canada ED	Proportion of children ***with*** episodes of vomiting, <24 hours after treatment	**Ondansetron** 14% RR=0.40 [95% CI 0.26 to 0.61] NNT=5	**Placebo** 35%	P<0.001			
Efficacy of Ondansetron versus placebo for reducing episodes of vomiting (oral administration)									
Freedman, Hall, et al., 2014 (RCT)	215 children	Canada ED	Mean number of episodes of vomiting <24hours	**Ondansetron** 0.18 RR= 0.30 [95% CI 0.18 to 0.50]	**Placebo** 0.65	P<0.001			

[26] IV anti-emetic results were not reported as the intention of ondansetron in the context of the BCB was to prevent the need for an IV line so these results were felt to be moot.
[27] A fourth study did test this but was found to increase heterogeneity and was thus removed for the analysis.
[28] RR= Risk ratio:

Study	No of participants	Setting	Outcome measures	Results				Comments	Level of evidence
Efficacy of Ondansetron versus placebo for reducing episodes of vomiting (oral administration) *Continued*									
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Mean number of episodes of vomiting <24hours	**Study**	**Ondansetron**	**Placebo**	**p**	Compared with placebo Ondansetron may be more effective at reducing episodes of vomiting within 24 hours of treatment	Low
				1(RCT 1, n=36)	2	5	0.049		
				2 (RCT 1, n=145)	0.75	0.96	0.96		
				3 (RCT 1, n=205)	0.18	0.65	p<0.001		
				4 (RCT 1, n=109)	0.36	1.33	p<0.001		
Efficacy of Ondansetron versus placebo for reducing iv fluid requirement (oral administration)									
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Required IVF (immediately)	**3 studies included** RR =0.41 [95% CI 0.29-0.59] p<0.001; 1^2 =0% NNT of 5 [95% CI 4 to 8]					Low
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Require IVF (<72 hours)	**3 studies included** (Best-worst) RR=0.57 (0.42-0.76) p<0.001; 12 =0% (Worst-best) RR=0.53 (0.39-0.72) p<0.001; 1^2 =0% NNT was found to be between 4 and 13.					Low
Freedman, Hall, et al., 2014 (RCT)	215 children	Canada ED	Proportion of children requiring IVF	**Ondansetron** 14% RR=0.46 [95% CI 0.26‑0.79] NNT=6	**Placebo** 33%	P = 0.003			
Hervás et al., 2012 (CS)	1871 children 0-14 years	Spain ED	Risk of IVF	RR= 0.31 [95% CI, 0.14-0.63] NNT= 7 [95% CI, 5-22]				Significant methodological flaws (blinding and treatment allocation)	
Efficacy of Ondansetron versus placebo for reducing admission rates (oral administration)									
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Admitted (immediately)	**3 studies included** RR= 0.43 (0.18-100) p=0.05; 1^2 =17%					Low
			Admitted (<72hour)	**3 studies included** (Best-worst) RR=0.6 (0.34-1.04) p=0.07; 1^2 =49% (Worst-best) RR=0.73 (0.43-1.23) p=0.24; 1^2 =0%					Low

Study	No of participants	Setting	Outcome measures	Results				Comments	Level of evidence
Efficacy of Ondansetron versus placebo for reducing admission rates (oral administration) *Continued*									
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Proportion of children admitted to hospital	**4 studies** 1 (RCT 1, n=145) 2 (RCT 1, n=205) 3 (RCT 1, n=106) 4 (RCT 1, n=109)	**Ondansetron** No data 4% 6% 2%	**Placebo** No data 5% 13% 22%	**p** 0.007 1 - <0.001	Compared with placebo Ondansetron may be more effective at reducing admissions to hospital	Very low
Freedman, Hall, et al., 2014 (RCT)	215 children	Canada ED	Proportion of children requiring admission	**Ondansetron** 4% *RR=0.80 (95% CI 0.22 -2.90)*	**Placebo** 5%				Low
Hervás et al., 2012 (CS)	1871 children 0-14 years	Spain ED	Risk of hospital admission	*RR=0.22; (95% CI 0.08-0.63)* *NNT= 8 (95% CI 5-22);*				Significant methodological flaws (blinding and treatment allocation)	Very low
Sturm et al., (2009) Retrospective review	34,117 children	USA ED	Odds of admission on index visit	*OR =0.47 (95% CI 0.42 to 0.53)*				Significant bias issues. Fewer children who received Ondansetron were admitted to hospital on their initial visit.	Very low
Sturm et al., (2009) Retrospective review	34,117 children	USA ED	Odds of admission on revisit	*OR =1.74;* *(95% CI 1.39 to 2.19)*		Of those who revisited within 72 hours (1.3%) a higher proportion had received Ondansetron during their index visit (70%). Overall the rate of admission was lower in the group given Ondansetron 5.3% compared with 7.3%.			Very low
Efficacy of Ondansetron versus placebo for reducing length of stay									
Hervás et al., 2012 (CS)	1871 children 0-14 years	Spain ED	Length of Stay	**Mean LOS (hours) (IQR)** Ondansetron 161 (103-224) Placebo 153 (111-210) P=0.81				No difference	Very low
Efficacy of Ondansetron versus placebo for reducing revisit rates (oral administration)									
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Revisit rate (<72 hours)	**3 studies included** RR=1.24 (0.49-3.15) p=0.66; 1^2 =28%				No statistical difference	Low
Sturm et al., (2009) (CS)	34,117 children	USA ED	Odds of revisit (<72hours)	OR 1.45; [95% CI 1.27 to 1.65]				Patients who received Ondansetron were more likely to revisit.	Very low

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of Ondansetron within the dose ranges 0.13-0.26mg/kg (oral administration)								
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Volume of ORT consumed	Pearson's Correlation coefficient r = -0.088; p = 0.36			No correlation between dose and effect	Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Weight gain	r = -0.002; p = 0.98			No correlation between dose and effect	Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Cessation of vomiting	tau = 0.093; p = 0.24			No evidence of a dose-response relationship between those who vomited and those who did not or the frequency of vomiting during oral rehydration therapy in the ED	Very low
	105 participants	US ED	Dosage in those children who vomited	Vomited Did NOT vomit	**Mean dose Ondansetron** *0.21 – 0.03 mg/kg* *0.20 – 0.03 mg/kg*			Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Frequency of diarrheal episodes (per hour)	r = -0.063; p = 0.52			Statistically non-significant	Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	ED LOS	r = 0.062; p = 0.52				Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Adverse events	None reported				Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Ondansetron dose and IVF requirement	Received IVF Did NOT receive IVF	**Mean dose Ondansetron** 0.21 – 0.03 mg/kg 0.20 – 0.03 mg/kg			Very low
Freedman, Powell, et al., (2010) (CS)	105 participants	US ED	Admitted to Hospital	Admitted NOT admitted	**Mean dose Ondansetron** *0.20 – 0.02mg/kg* *0.20 – 0.03 mg/kg*			Very low
Adverse Effects Reported for Ondansetron versus placebo (oral administration)								
Freedman, Hall, et al 2014., (RCT)	215 children	Canada ED	No of episodes of diarrhoea	**Ondansetron** 1.4	**Placebo** 0.5	*P<0.001*	Ondansetron associated with increased risk of diarrhoea episodes	Low

Appendix N
Theme Five: Adjunct Therapies – Results Tables

Study	No of participants	Setting	Outcome measures	Results				Comments	Level of evidence
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Episodes of diarrhoea <24 hours	**5 Studies**	**Ondansetron**	**Placebo**	**p**	Ondansetron may be associated with an increased risk of episodes of diarrhoea	Low
				1 (RCT 1, n=36)	-	-	0.013		
				2 (RCT 1, n=145)	4.7	1.37	0.02		
				3 (RCT 1, n=215)	1.4	0.5	0.001		
				4 (RCT 1, n=106)	0-20	0-6	No data		
				5 (RCT 1, n=109)	5.04	4.3	0.04		
Impact of Ondansetron on cost of care									
Hervás et al., 2012 (CS)	1871 children 0-14 years	Spain ED	Medical costs Hospitalization costs	**Ondansetron Group** *US $22,078* *US $9600.*		**Non-Ondansetron Group** *US $21,987* *US $25,079 (73.7% saving)*		No difference medical costs reduced hospitalisation costs. Significant methodological flaws (blinding and treatment allocation)	Very low
Correlation between Ondansetron use and other outcome measures (cohort study: 20% of eligible visits over 5 years after Ondansetron introduced)									
Freedman et al., 2012 (CS)	3508 patient visits	Canada ED	Use of intravenous rehydration	**Reduction over 5 years** *27%–13%*		*P<0.001*		As Ondansetron use has increased, need for IVF has decreased.	Very low
Freedman et al., 2012 (CS)	3508 patient visits	Canada ED	Use of Ondansetron	**Increase over 5 years** *1%–18%*		*P<0.001*		*Time-series analysis demonstrated a level break (P=0.03) following the introduction of Ondansetron*	Very low
Freedman et al., 2012 (CS)	3508 patient visits	Canada ED	Mean LOS	**Decrease over 5 years** 8.6+/- 3.4 to 5.9+/-2.8 hours		P=0.03		As Ondansetron use has increased the mean LOS has decreased	Very low
Freedman et al., 2012 (CS)	3508 patient visits	Canada ED	Revisit within 7 days	**Decrease over 5 years** 18%–13%		P=0.008		As Ondansetron use has increased the revisit rate has decreased	Very low

Table 26: Results for Additional Interventions for Adjunct Therapies

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Granisetron versus placebo in children with gastroenteritis (oral administration[29])						
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Granisetron versus Placebo (cessation of vomiting)	**Unclear how many studies were included**[30] OR of 3.25 [95% CI 0.62 to 17.69] p<0.05	Less clear odds due to wide CIs	Low
Carter & Fedorowicz 2012 (SR)	10 Studies (1049 Participants)	USA, Turkey Germany Venezuela	Granisetron versus Ondansetron (cessation of vomiting)	OR of 1.33 [95% CI 0.21 to 8.76]	Less clear odds due to wide CIs Estimated best treatment option: Ondansetron 65%, Granisetron 35% and placebo 0%	Low
Efficacy of Domperidone in children with gastroenteritis (rectal administration)						
Kita et al 2015., (RCT)	56 children	Japan ED/GP	Percentage with vomiting (overall)	ORT group 27.3% ORT & domperidone group 20.7% (*P* = 0.41)	Compared ORT/ORT plus domperidone, underpowered, blinding issues, patient selection issues. No statistical difference shown.	Very low
Kita et al 2015., (RCT)	56 children	Japan ED/GP	Percentage with vomiting (48-72 hours post treatment)	ORT group 27.3% ORT & domperidone group 3.57% (*P* = 0.02)	Methodological issues. Favours domperidone use, no statistically significant difference from 2 hours to 48 hours between the groups.	Very low

[29] IV anti-emetic results were not reported as the intention of ondansetron in the context of the BCB was to prevent the need for an IV line so these results were felt to be moot.
[30] Mixed treatment comparison (MTC) were estimated using a fixed effects model within a Bayesian framework.

Appendix N
Theme Five: Additional Interventions for Adjunct Therapies

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of Dimenhydrinate versus placebo in children with gastroenteritis						
Gouin et al., 2012 (RCT)	144 children	USA ED	No. of vomiting episodes in the following 24 h	**N (SD)** Dimenhydrinate 1.0 +/-.3 1 Placebo 1.6 +/- 2.7 P=0.08	Dimenhydrinate effect not significant	Very low
Gouin et al., 2012 (RCT)	144 children	USA ED	No. of children requiring IVF	**N (%)** Dimenhydrinate 7 (9) Placebo 9 (13) P=0.35	Dimenhydrinate effect not significant	Very low
Gouin et al., 2012 (RCT)	144 children	USA ED	No. of revisits	**N (%)** Dimenhydrinate 11 (15) Placebo 18 (26) P=0.08	Dimenhydrinate effect is not significant	Very low
Efficacy of Racecadotril versus placebo in children with gastroenteritis						
Lehert et al., 2011 (SR)	9 RCTS, 1384 children	France, Peru, India, Spain, Guatamale, Mexico	Median duration of diarrhoea	**Racecadotril** 1.75 days **Placebo** 2.81 days	Racecadotril reduces duration of diarrhoea.	Low
Lehert et al., 2011 (SR)	9 RCTS, 1384 children	France, Peru, India, Spain, Guatamale, Mexico	Number of children who recovered	**Hazard Ratio** HR = 2.04, [95% CI 1.85; 2.32] P < 0.001.	Twice as many recovered at any time with Racecadotril No difference between age ranges, European/non-European country were found.	Low
Lehert et al., 2011 (SR)	9 RCTS, 1384 children	France, Peru, India, Spain, Guatamale, Mexico	Mean stool output ratio	**Inpatient studies** 0.59 (0.51; 0.74), P < 0.001. I^2 = 31	Racecadotril reduces stool output	Low

Study	No of participants	Setting	Outcome measures	Results		Comments	Level of evidence
Efficacy of Racecadotril versus placebo in children with gastroenteritis *continued*							
Lehert et al., 2011 (SR)	9 RCTS, 1384 children	France, Peru, India, Spain, Guatamale, Mexico	Mean ratio of number of diarrhoeic stools	**Outpatient studies**, 0.63 [95% CI0.47 to 0.85] P < 0.001 I^2 = 0.26		Racecadotril reduces number of stools	Low
Economic impact of using of Racecadotril versus just ORT in children with gastroenteritis							
Rautenberg et al., 2012 (EE)	Participants from Lehert et al entered into decision tree model		Cost savings using Racecadotril + ORT versus ORT alone	-£379 or $924 NZD Based on reductions in primary care revisits and secondary referrals.		Based on UK costings.	Very low
	Participants from Lehert et al entered into decision tree model		Quality-adjusted life years (QALYs)	+ 0.0008 years with Racecadotril			Very low
Efficacy of Loperamide versus placebo in children with gastroenteritis							
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Duration of diarrhoea	**Study** 1 (RCT 6, n=976) 2 (RCT 1, n=145)	**Mean reduction (days)** 0.8 [95% CI 0.7 to 0.9] significant –0.67 [95% CI –1.35 to +0.01] not significant	Loperamide may be more effective at reducing the duration of diarrhoea in children, but this is certain, as results were sensitive to the method of analysis used	Very low
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Adverse Events	**Study** 1 (RCT 12, n=1691)	**Absolute Risk Increase** ARI 8.6% [95% CI 6.4% to 10.9%]	Although loperamide reduces the persistence of acute diarrhoea in children, it is not recommended for children under 3 years of age because the risk of adverse effects outweighs the benefits in this group.	Very low
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Serious adverse effects (defined as ileus, lethargy, or death)	**Study** 1 (RCT 12, n=1691	**Absolute Risk Increase** ARI +0.8% [95% CI –0.1% to +1.8%]		

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of Loperamide versus placebo in children with gastroenteritis *continued*								
Dalby-Payne & Elliott 2011	42 SR or RCTS	Developed and developing	Serious adverse effects (defined as ileus, lethargy, death abdominal distension, and sleepiness)	**Study** 1 (RCT 12, n=1691	**Absolute Risk Increase** ARI 1.8% [95% CI 0.6% to 3.1%]		Dalby-Payne & Elliott 2011	42 SR or RCTS
Efficacy of zinc versus placebo in children with gastroenteritis								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of diarrhoea	**Study** 1 (RCT 13, n=5643) 2 (RCT 9, n=2741)	**WMD (days)** –0.69 P <0.0001 –12.27 P =0.025	**95% CI (days)** –0.97 to –0.40 –23.02 to –1.52	Zinc reduces duration of diarrhoea (but not total stool volume) compared with placebo (mainly developing countries). Additional studies are required to assess the benefit in developed countries.	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Total stool volume	**Study** 1 (RCT 13, n=5643)	**SMD**[31] –0.38	**95% CI (mLs)** –1.04 to +0.27		Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Proportion of children with vomiting	**Study** 1 (RCT 5, n=3156) 2 (RCT 8, n=4727)	**RR** 1.22 1.71 P <0.0004	**95% CI** 1.05 to 1.43 1.27 to 2.30	Zinc may increase vomiting compared with placebo.	Very low
Efficacy of probiotics versus placebo in children with gastroenteritis[32]								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of diarrhoea	**Study** 1 (RCT 7, n=679) 2 (RCT 4, n=231) 3 (RCT 4, n=297) 4 (RCT 1, n=473)	**WMD (hours)** –20.1 –38.1 P = 0.01 –24.8 P <0.0001 –1.1	**95% CI (hours)** –26.1 to –14.2 –68.1 to –8.10 –31.8 to –17.9 –1.3 to –0.83	Probiotics assessed in included RCTs: *Lactobacillus GG*, *L reuteri*, *L acidophilus LB*, *Saccharomyces boulardii*, *Streptococcus, thermophilus lactis*, *L acidophilus*, and *L bulgaricus.* Favours treatment variation of effect.	Very low

[31] SMD= standardized mean difference
[32] Only reported duration of diarrhoea, stool volume and diarrhoea on days 3 and 4, duration of hospital stay and revisit rates.

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of probiotics versus placebo in children with gastroenteritis *continued*								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of diarrhoea	**Study** 1 (RCT 7, n=675)	**Mean Difference** 0.7 days	**95% CI (days)** 0.3 to 1.2	Probiotics assessed in included RCTs: *Lactobacillus GG*, killed *L acidophilus*, *L reuteri*, and a mixture of *L acidophilus* and *L bulgaricus.* Favours treatment.	Very low
Dinleyici et al., 2012 (SR)	19 studies 1128 children	Developed and developing	Duration of diarrhoea	11 RCTS 1306 children	**WMD (days)** 0.99	**95% CI (days)** -1.40 to -0.58	Probiotics assessed in included RCTs: Saccharomyces Boulardii. Large variance between studies Methodological issues. Favours treatment.	Very low
Szajewska, Ruszczynski, et al., 2014 (SR)	4 studies	Developed and developing	Duration of Diarrhoea	224 children (3 studies Inpatient)	**Mean Difference** -21.6 hours	**95% CI (hours)** -26.5 to -16.6 I^2 = 24%	Probiotics assessed in included RCTs: Lactobacillus acidophilus LB. Low heterogeneity. Favours treatment.	Very low
Szajewska et al., 2013 (SR)	15 studies 2963 participants	Inpatient and outpatient	Duration of diarrhoea	11 RCTs 2444 participants	**Mean Reduction** 1.05 days	**95% CI (days)** 1.7 to 0.4 I^2 = 98%	Probiotics assessed in included RCT: Lactobacillus GG Significant heterogeneity. Favours treatment. Largest effect was seen in European studies, at doses ≥1010 CFU/day.	Very low
Szajewska, Urbanska, et al., 2014 (SR)	5 RCTs 352 participants	Finland, Italy, Korea Turkey, Inpatient	Duration of diarrhoea	2 RCTs (n=196)	**Mean Difference** 32.4 (hours)	**95% CI (hours)** -41 to -24 I^2=0%	Probiotics assessed in included RCTs: Lactobacillus reuteri DSM 17938 Significant reduction in duration of diarrhoea no heterogeneity was found.	Very low
Freedman, Sherman, et al., 2015., (RCT)	123 children	Canada ED	Duration of diarrhoea		**Mean difference (SD)**	**P**	Probiotics assessed in included RCTs: *L helveticus*/L *rhamnosus.* No significant difference. Underpowered	Low
				Placebo	63.5 ± 64.3 hours			
				Low dose	59.1 ± 55.2 hours	0.27		
				High dose	84.0 ± 96.4 hours	0.68		
Allen et al., 2010 (SR)	56 studies 8014 participants	Developed and developing	Duration of diarrhoea	**Study** 1 (RCT 35, n=4555)	**Mean Difference** 24.76 hours	**95% CI (hours)** 15.9 to 33.6	Wide variation in methodology and magnitude of effect. Probiotics assessed in included RCTs: *L. casei* strain GG (13 studies), *S. boulardii* (10 studies) and *Enterococcus* lactic acid bacteria (LAB) SF68 (five studies). Favours treatment.	Very low

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of probiotics versus placebo in children with gastroenteritis *continued*								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Proportion of children with episodes of diarrhoea, 3 days	**Study** 1 (RCT 8, n=731) 2 (RCT 11, n=1008)	**RR** 0.43 P <0.0001 0.68 P <0.0008	**95% CI** 0.34 to 0.53 0.54 to 0.85	Probiotics assessed in included RCTs: *Lactobacillus GG*, *L reuteri*, *L acidophilus LB*, *Saccharomyces boulardii*, *Streptococcus thermophilus lactis*, *L acidophilus*, and *L bulgaricus* probiotics. Favours treatment.	Very low
Dinleyici et al., 2012 (SR)	19 studies 1128 children	Developed and developing	Risk of diarrhoea on day 3	9 RCTs 1128 children	RR=0.52	**95% CI** 0.42 -- 0.65	Probiotics assessed in included RCTs: Saccharomyces Boulardii. Large variance between studies Methodological issues. Favours treatment.	Very low
Szajewska et al., 2013 (SR)	15 studies 2963 participants	Inpatient and outpatient	Risk of diarrhoea on day 3	3 RCTs 393 participants	**RR** 0.64	**95% CI (days)** 0.36 to 1.13 I^2 = 56%	Probiotics assessed in included RCT: Lactobacillus GG Significant heterogeneity. Favours treatment.	Very low
Szajewska, Ruszczynski, et al., 2014 (SR)	4 studies 304 children	Developed and developing	Cessation of diarrhoea on day 3	144 children (2studies Inpatient)	**RR** 1.03	**95% CI** 0.88 to 1.2 I^2 = 0%	Probiotics assessed in included RCTs: Lactobacillus acidophilus LB. Low heterogeneity. No statistical significance	Very low
Szajewska, Urbanska, et al., 2014 (SR)	5 RCTs 352 participants	Finland, Italy, Korea Turkey, Inpatient	Cessation of diarrhoea on day 3	2 RCTs (n=196)	**RR**[33] 3.5	**95% CI** 1.15 to 10.8	Probiotics assessed in included RCTs: Lactobacillus reuteri DSM 17938 Significant reduction in duration of diarrhoea but significant heterogeneity.	Very low
Szajewska et al., 2013 (SR)	15 studies 2963 participants	Inpatient and outpatient	Risk of diarrhoea on day 4	1 RCTs 64 participants	**RR** 1.07	**95% CI (days)** 0.44 to 2.61	Probiotics assessed in included RCT: Lactobacillus GG No statistical significance.	Very low

[33] A random affect model was used due to heterogeneity of I^2 =82% using fixed effects.

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Efficacy of probiotics versus placebo in children with gastroenteritis *continued*								
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Proportion of children with episodes of diarrhoea, 4 days	**Study** 1 (RCT 9, n=895)	**OR** 0.43 P=0.0006	**95% CI** 0.24 to 0.68	Probiotics assessed in included RCTs: lactobacilli and *Saccharomyces boulardii.* Favours treatment.	Very low
Szajewska, Ruszczynski, et al., 2014 (SR)	4 studies 304 children	Developed and developing	Cessation of diarrhoea on day 4	153 children (2studies Inpatient)	**RR** 1.44	**95% CI** 1.20 to 1.73 I^2 = 39%	Probiotics assessed in included RCTs: Lactobacillus acidophilus LB. Low heterogeneity. Favours treatment.	Very low
Allen et al., 2010 (SR)	56 studies 8014 participants	Developed and developing	Diarrhoea ≥4days	**Study** 1 (RCT 29, n=2853)	**RR** 0.41	**95% CI (hours)** 0.32 to 0.53	Wide variation in methodology and magnitude of effect. Probiotics assessed in included RCTs: *L. casei* strain GG (13 studies), *S. boulardii* (10 studies) and *Enterococcus* lactic acid bacteria (LAB) SF68 (five studies). Favours treatment.	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Frequency of stools, day 3	**Study** 1 (RCT 2, n=170)	**WMD (stools)** –1.12 P <0.0001	**95% CI (stools)** –1.79 to –0.46	Probiotics assessed in included RCT lactobacilli and *Saccharomyces boulardii,* Favours treatment.	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Number of stools, day 3	**Study** 1 (RCT 3, n=331) 2 (RCT 1, n=178) 3 (RCT 1, n=27)	**WMD (stools)** –1.3 **No of stools** 1.3 versus 2.3 1.68 versus 3.36	**95% CI (stools)** –1.9 to –0.63 P = 0.002 P <0.05	Probiotics assessed in included RCT: *Saccharomyces boulardii, yoghurt with L acidophilus.* Favours treatment.	Very low
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of hospital stay	**Study** 1 (RCT 1, n=200) 2 (RCT 1, n=80)	**WMD (days)** –1.0 **Actual days** 3.4 treatment 4.0 placebo	**95% CI (days)** –1.4 to –0.62 P = 0.03	Probiotics assessed in included RCT: *L acidophilus* Favours treatment.	Very low
Dinleyici et al., 2012 (SR)	19 studies 1128 children	Developed and developing	Duration of hospitalisation	449 children	**WMD (days)** 0.84	**95% CI (days)** 1.14 to -0.54	Probiotics assessed in included RCTs: Saccharomyces Boulardii. Large variance between studies Methodological issues	Very low

Appendix N
Theme Five: Additional Interventions for Adjunct Therapies

Study	No of participants	Setting	Outcome measures	Results			Comments	Level of evidence
Freedman, Sherman, et al., 2015 (RCT)	123 children	Canada ED	Proportion of children missing at least 1 full day of day care	**Treatment** 61% **Placebo** 63% **Absolute difference** 2.2%,	***P*** = .73;	**95% CI** 14.6% to 18.9%	Probiotics assessed in included RCTs: *L helveticus*/L *rhamnosus.* Using proportion of children with ≥1 missed days of child care may be flawed (as weekends skew the data) Number of days missed may have been a fairer comparison. No significant difference. Underpowered	Very low
Efficacy of Lactobacillus GG (LGG) plus Smectite versus LGG plus placebo								
Pieścik-Lech et al., 2013 (RCT)	88 children 4 to 60 month	Poland Hospital	Duration of diarrhoea	LGG/smectite LGG/placebo	**Median (days)** 2 2 P=0.43		No statistical difference Addition of smectite had no measurable difference.	Very low

Appendix N
Theme Six: Parental Advice – Results Tables

Table 27: Theme Six Study Characteristics

Study	Type of Study	Topic	BCB or Additional Intervention	Country	Setting	Participants	Age
Dalby-Payne & Elliott, 2011	Systematic Review	Lactose avoidance	Additional	Multiple [34]	ED & Community	42 SR or RCTS	1 month to 12 years
Gregorio et al., 2011	Systematic Review	Early vs delayed refeeding	BCB	Multiple[35]	ED & Community	12 RCTS, 1226 participants	1 month to 5 years
MacGillivray et al., 2013	Systematic Review	Lactose avoidance	Additional	Multiple[36]	ED & Community	33 RCTS participants 2973	<15 years

Table 28: Results for BCB Interventions Relating to Parental Advice

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of early versus late refeeding in children with gastroenteritis						
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple[37] Hospital & outpatient	Duration of diarrhoea (hours) from admission until cessation of diarrhoea	**RCTs 7, 685 participants** Late refeeding group showed longer duration compared with the early refeeding group MD -6.90 hrs, [95% CI -18.70 to 4.91] Chi2 test, P=0.11, I^2 = 82%	Not significant High heterogeneity between studies	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Mean total stool output (mL/kg) during first 24 & 48 hours after rehydration started.	**RCTs 3, 394 participants** *First 24hours I^2 of 85%* 2 out of 3 studies favoured late refeeding *48 hours after start of rehydration I^2 of 87%* 2 out of 3 studies favoured early refeeding	Inconsistent results Not significant High heterogeneity between studies	Low

[34] Developed and developing actual countries not stated
[35] UK, Italy, Finland, The Netherlands, Croatia, Slovenia, Czechoslovakia, Belgium, Portugal, Poland, USA, Burma, Israel, Egypt, Pakistan and Peru
36 Canada, UK, India, Peru, Guatemala, Brazil, USA, Australia, South Africa, Saudi Arabia, Finland, Colombia, Thailand, Venezuela, Iran, Algeria, Germany, China,
[37] UK, Italy, Finland, the Netherlands, Croatia, Slovenia, Czechoslovakia, Belgium, Portugal, Poland, USA, Burma, Israel, Egypt, Pakistan and Peru

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of early versus late refeeding in children with gastroenteritis *continued*						
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Percentage weight gain 24 hours after start of rehydration	**RCTs 3, 212 participants** No difference between groups *I^2 of 0%*	Not significant	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Percentage weight gain at resolution of diarrhoea.	**RCTs 3, 322 participants** Favoured late refeeding but effect size was small MD 0.60 [95% CI -0.27- 1.47] P = 0.18 I^2 of 0%	Not significant	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Unscheduled intravenous (IV) fluid therapy	**RCTs 6, 813 participants** RR 0.87 [95% CI 0.48, 1.59] P = 0.65 I^2 of 0%	Favours early refeeding Not significant	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Cases of vomiting	**RCTs 5, 456 participants** RR 1.16 [95% CI 0.72, 1.86] P = 0.55, I^2 of 0%	Favours late refeeding Not significant	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Adverse events: Development of persistent diarrhoea	**RCTs 4, 522 participants** RR 0.57 [95% CI 0.18, 1.85] P = 0.35 I^2 of 0%	Favours early refeeding Not significant	Low
Gregorio et al., 2011 (SR)	12 RCTS 1226 children	Multiple Hospital & outpatient	Adverse events: Development of hyponatraemia.	**RCT 2, 187 participants** RR 0.68 [95% CI 0.06, 7.29] P = 0.75 I^2 of 0%		Low

Table 29: Results for Additional Interventions Relating to Parental Advice

Study	No of participants	Setting	Outcome measures	Results				Comments	Level of evidence
Efficacy of lactose free versus lactose containing feeds in children with gastroenteritis									
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Mean duration of diarrhoea	**Study**	**Lactose (hours)**	**Lactose free (hours)**	**p**	Lactose-free feeds may be more effective at reducing the duration of diarrhoea in children with mild to severe dehydration	Low
				1 (RCT 9, n=826)	92	88	?[38]sig		
				2 (RCT 6, n=604)	95	82	?		
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Duration of diarrhoea	**Study**	**Lactose (hours)**	**Lactose free (hours)**	**p**	Lactose-free feeds may be more effective at reducing the duration of diarrhoea in children with mild to severe dehydration	
				1 (RCT 1, n=76)	158	198	<0.01		
				2 (RCT 1, n=60)	-	-	no sig*		
				3 (RCT 1, n=52)	-	-	no sig*		
				4 (RCT 1, n=200)	39	23	<0.001		
				5 (RCT 1, n=91)	38	25	<0.03		
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Weight gain	**Study**	**Lactose**	**Lactose free**	**p**	It is unclear whether lactose-free feeds are more effective at improving weight gain	Low
				1 (RCT 1, n=76)	-	-	no sig*		
				2 (RCT 1, n=60)	-	-	no sig*		
				3 (RCT 1, n=52)	-	-	no sig*		
				4 (RCT 1, n=200)	-	-	no sig*		
				5 (RCT 1, n=91)	7.84kg	7.48kg	<0.05		
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Total stool volume	**Study**	**Lactose**	**Lactose free**	**p**	Lactose-free feeds may be more effective at reducing total stool volume	Low
				1 (RCT 4, n=209)	-	-	0.002		
Dalby-Payne & Elliott 2011 (SR)	42 SR or RCTS	Developed and developing	Mean total stool volume	**Study**	**Lactose**	**Lactose free**	**p**	Lactose-free feeds may be more effective at reducing total stool volume	Low
				1 (RCT 1, n=200)	164 mL/kg	69mL/kg	<0.001		

[38] Reported as significant but no actual data given; * reported as NOT significant but no actual data was listed.

Study	No of participants	Setting	Outcome measures	Results	Comments	Level of evidence
Efficacy of lactose free versus lactose containing feeds in children with gastroenteritis *continued*						
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Duration of Diarrhoea	**16 trials, 1467 participants** MD -17.77 hours, [95% CI -25.32 to -10.21] Random-effects model, I^2 = 67%, P < 0.00001	Favours Lactose free feeds Significant heterogeneity	Moderate
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Treatment failure	**18 trials, 1470 participants** Risk reduction with lactose free feeds RR 0.52, [95% CI 0.39 to 0.68] Fixed-effect model, I^2 = 0%, P < 0.00001 Overall, lactose-free products resulted in 8 fewer treatment failures per 100 children treated RD -0.08, [95% CI -0.11 to -0.05] NNTB of 12 [95% CI 9 to 20]	Favours Lactose free feeds No heterogeneity	Moderate
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Hospitalisation	**1 trial, 83 participants** RR 0.79, [95% CI 0.09 to 6.65] P = 0.83	No statistical difference	Moderate
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Duration of hospital stay	**5 trials, 246 participants** MD -0.31 days, [95% CI -0.83 to 0.21] Fixed-effect model, I^2 = 0%, P = 0.24	No statistical difference	Moderate
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Stool volume	**3 trials, 194 participants** MD -9.23 g/kg/day [95% CI -32.61 to 14.14] P = 0.44	No statistical difference	Moderate
MacGillivray et al., 2013 (SR)	33 RCTS participants 2973	Inpatient and outpatient	Change in body weight	**2 trials, 228 participants** MD -0.25 [95% CI -0.92 to 0.42] P = 0.47	No statistical difference	Moderate