Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Association for Academic Surgery

Infectious outcomes of gastroschisis patients with intraoperative hypothermia

Rachel M. Landisch, MD,[a,*] *Roxanne L. Massoumi, MD,*[b] *Melissa Christensen, BS, CCRC,*[c] *and Amy J. Wagner, MD*[a,c]

[a] *Department of Surgery, The Children's Hospital of Wisconsin and The Medical College of Wisconsin, Milwaukee, Wisconsin*

[b] *Department of Surgery, University of California Los Angeles, Surgery, Los Angeles, California*

[c] *Division of Pediatric Surgery, The Children's Hospital of Wisconsin and The Medical College of Wisconsin, Milwaukee, Wisconsin*

ARTICLE INFO

Article history:
Received 22 December 2016
Received in revised form
22 February 2017
Accepted 29 March 2017
Available online 6 April 2017

Keywords:
Gastroschisis
Hypothermia
Surgical site infection
Complications

ABSTRACT

Background: Perioperative hypothermia decreases nutrient and oxygen delivery to tissues and, in adult studies, increases the risk of infectious complications (ICs). Gastroschisis (GS) places newborns at risk for hypothermia by nature of exposed viscera and excessive heat loss. Although hypothermia is a known cause of mortality in GS, the rate of ICs in this at-risk cohort has not yet been delineated.

Materials and methods: A retrospective cohort study was performed at our single tertiary-referral hospital, evaluating patient and operative characteristics of all GS infants who underwent operative closure. Intraoperative temperatures were recorded, defining hypothermia as mild (35.5°C-35.9°C), moderate (35.0°C-35.4°C), or severe (<35°C). Temperature nadirs, procedural and anesthesia duration were observed. The primary outcome was 30-d surgical site infections. Secondary measures included other ICs.

Results: Among 43 GS neonates, 21 (48.8%) had intraoperative hypothermia, classified as mild in 2 (4.7%), moderate in 8 (18.6%), and severe in 11 (25.6%). Nineteen ICs occurred in 35.9% of patients, including 10 (23.3%) surgical site infections. There was no association between hypothermia and ICs. Patient and operative characteristics were similar between normothermic and hypothermic groups, except that normothermic infants were more likely to have silos placed with delayed closure than hypothermic patients (63.6% *versus* 23.8%, $P = 0.01$).

Conclusions: Infants with GS are at high risk for hypothermia and ICs, though newborns with silos were less subject to temperature lability. A multiinstitutional study with greater power is needed to further investigate the relationship between perioperative hypothermia and surgical ICs.

* *Corresponding author*. General Surgery Resident, Medical College of Wisconsin, Pediatric Surgery Research Fellow, Children's Hospital of Wisconsin, 999 North 92nd Street, Suite CCC320, Milwaukee, WI 53226. Tel.: +414 266 6553; fax: +414 266 6579.
E-mail address: rlandisc@mcw.edu (R.M. Landisch).

0022-4804/$ – see front matter © 2017 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jss.2017.03.053

Introduction

Gastroschisis (GS), the most common congenital abdominal wall defect, is frequently associated with preterm delivery and is increasing in incidence.[1-3] Advances in perinatal management, nutrition, and surgical techniques have improved GS outcomes[4-6]; however, newly published data from over 2 decades exposed the substantial morbidity of GS neonates who, in comparison to omphalocele infants, have longer hospitalizations, parenteral nutrition, and higher rates of infection.[1] More alarming was the apparent trend of increasing mortality among GS infants over time, which was significantly associated with systemic infection.

Neonates are inherently at higher risk of acquiring nosocomial and opportunistic infections owing to immature immunologic defenses. In addition, GS newborns become incrementally more vulnerable after multiple surgical interventions and a prolonged length of stay (LOS) in the neonatal intensive care unit (NICU), all of which are essential factors in placing GS neonates among the highest risk for infectious complications (ICs). With the rate of IC reaching as high as 23.5% in GS patients,[1] many studies have focused on quality efforts to minimize infectious risk in an effort to improve outcomes and reduce health care resource utilization and costs[7]; yet, standardization of care and consensus on best management do not exist.

Perioperative hypothermia, the result of impaired thermoregulation secondary to general anesthesia with subsequent heat redistribution and ultimate heat loss, increases the risk for wound infections and coagulopathy.[8,9] Adult studies have established an association between intraoperative hypothermia and surgical site infections (SSI), with especially heightened risk among patients who experienced severe intraoperative hypothermia (i.e., <35.0 C).[10,11] For this reason, maintenance of intraoperative normothermia has emerged as an important quality metric in the care of surgical patients. In addition to a neonate's inability to thermoregulate, GS newborns have exposed viscera and an inherent risk for excessive heat loss, putting them at increased risk for hypothermia. Though previous literature established an increased mortality risk among hypothermic GS patients,[12,13] pediatric data quantifying infectious risk with perioperative hypothermia is scarce, and none are specific to this susceptible cohort.

With this study, we sought to determine if intraoperative hypothermia is a modifiable factor associated with ICs in GS neonates. Specifically, in patients with GS undergoing operative closure, we aimed to (1) investigate the impact of procedural duration on development of hypothermia, (2) identify operative variables correlating with hypothermia, and (3) establish if an association exists between severe hypothermia (<35°C) and SSIs.

Materials and methods

Subjects

After institutional review board approval was granted, a retrospective review and applicable waiver of consent of all infants in the NICU with GS who underwent surgical closure between January 2013 and October 2016 at Children's Hospital of Wisconsin were performed. Infants who underwent bedside closure were excluded from the primary analysis owing to less frequent temperature recordings.

Using the electronic medical record, patient characteristics including gender, ASA, estimated gestational age (GA), and birth weights were collected. GS specific patient elements, such as the presence of a silo prior to closure and complex GS, defined as necrosis, perforation, volvulus, or atresia, were identified.[14]

Operative characteristics

All patients underwent general anesthesia and were treated prophylactically with antibiotics, the most commonly utilized being a weight based dose of ampicillin or piperacillin–tazobactam. Patients were kept warm with overhead heating lights, maintenance of operating room temperature at 29°C (85°F), and an underbody warming gel pad. Intraoperative core body temperature measurements were recorded, obtained from either an esophageal or a rectal temperature probe.

Days to surgical closure were recorded. Two time periods were observed, distinguished as (1) the procedural period and (2) the anesthesia period. The procedural period was defined as the time from procedure initiation to closure, or the duration during which the surgeon is actively operating on the patient. The anesthesia period is the total time elapsed between arrival to the operating room until departure from the OR, encompassing both the procedural period and additional perioperative time taken by the anesthesia team. The depth and duration of intraoperative hypothermia were evaluated using the following temperatures of interest: anesthesia start, procedure start, anesthesia period temperature nadir (i.e., overall nadir), and procedural period temperature nadir (i.e., nadir of the surgical portion of procedure). Hypothermia was defined as a temperature <36.0°C and was classified as mild (35.5°C-35.9°C), moderate (35.0°C-35.4°C), or severe (<35.0°C).

The primary outcome measure was the diagnosis of SSI, defined as documentation of erythema by a surgical team member and the institution of antibiotics specifically for the surgical site, within 30 d of surgery. Site infections were additionally classified by CDC criteria into superficial incisional, involving the skin and subcutaneous tissues, and deep incisional SSIs, involving the deep soft tissues (e.g., fascial and muscle layers).[15] Secondary outcomes included the following ICs: urinary tract infection, necrotizing enterocolitis, central line-associated bloodstream infection bacteremia, sepsis, and ventilator-associated pneumonia.

Statistical analysis

The rate of hypothermia was calculated as the number of patients with an intraoperative temperature nadir <36.0°C. Normothermic infants were compared to hypothermic infants. Normally distributed continuous data were compared between groups using a t-test or a Mann–Whitney test where the data were skewed. Descriptive data are reported as the mean ± standard deviation (SD). Categorical variables were compared using a chi-square test or a Fisher's exact test for smaller subsets. Subanalysis was performed on patients with