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Outcomes following the establishment of Qatar's quaternary neonatal general surgical service in a hospital with a "Tabula Rasa" for service development

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KEYWORDS

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ABSTRACT

Background: Sidra Medicine is the first dedicated Children and Maternity hospital in the State of Qatar. This paper describes the preparations for and results of activating quaternary neonatal surgical services in a brand new, "greenfield" hospital. We believe that these are the first published national results of neonatal general surgical services from the Gulf region.

Methods: A review of surgical babies below four weeks corrected age from 1st of April 2018 – 31st of March 2020 was undertaken. Patient demographics, primary diagnosis, surgical procedures, 30-day postoperative mortality, overall mortality, and cause of death were recorded.

Results: One hundred and sixty-nine babies (169) were identified (44.4% term and 55.6% preterm). Major surgery included laparotomy (76), congenital diaphragmatic hernia repair (20), surgery for anorectal malformations (25), and esophageal atresia (13). One set of conjoined twins were also separated successfully. Fourteen babies died, resulting in overall mortality of 8.3 %. Excluding babies who died of life-limiting conditions, two babies died within 30 days of surgery, resulting in 30 days postoperative mortality rate of 1.2 %.

Conclusions: The neonatal surgical mortality rate is comparable with those from top international centers. This low rate could be attributed to the high level of expertise preceded by months of preparations.

INTRODUCTION

Neonatal Surgical services have advanced rapidly in the last thirty years. Advancements in neonatal intensive care, parenteral nutrition, neonatal anesthesia, and the establishment of multidisciplinary teams have led to reduced mortality in complex neonatal surgical interventions.

In mature healthcare systems, neonatal and surgical teams usually have established mutual communication and working patterns, care pathways, and guidelines, with appropriate rapport and understanding between team members.

Sidra Medicine is the first dedicated Children and Maternity hospital in the State of Qatar. It is a state-of-the-art hospital that provides quaternary services to the State of Qatar and other regional countries as required. The hospital opened to major inpatient admissions in January 2018.

Inpatient neonatal surgical, cardiac, and pediatric specialty care services were activated in April 2018, with all neonatal surgical cases in the State of Qatar being referred to Sidra Medicine (both antenatally and postnatally) as the only licensed institution in the country to manage such cases.

This paper describes the preparations for, and results of, activating highly complex services within a new estate, a "tabula rasa" with healthcare personnel from over 90 countries, many of whom were international experts within their fields (but have never worked with one another previously), along with lessons learned.

A multinational, multidisciplinary team comprising nurses, doctors, allied healthcare professionals, managers, and support workers was appointed by the organization and united to establish the highest quality services for babies requiring surgical, cardiac, and

pediatric specialist care. Qatar's national neonatal general surgical outcomes are presented as a marker of the success of this initiative. We believe this is the first published paper of national neonatal general surgical results from the Gulf region.

METHODS

Development of Neonatal surgical services

The new Sidra Neonatal Intensive Care Unit (NICU) comprises 54 single-patient rooms with state-of-the-art equipment and an electronic medical patient record system. There are about 180 nurses, 45 medical staff and Nurse Practitioners, as well as many different Allied Health Care Professionals, information technologists, managers, and support staff, who needed to be involved with the planning of the facility, acquisition of equipment, education, and training and pathway development for the delivery of clinical services. As preparation for providing inpatient care, all team members were involved with developing guidelines, workflows, policies, and procedures that aligned as much as possible with Joint Commission International (JCI) standards and those pre-existing within the country. Key stakeholders included surgeons from all other disciplines and (but not limited to) anesthetists, materno-fetal medicine and maternity, cardiology, and pediatric specialist service providers.

The guidelines, workflows, policies, and procedures were disseminated through lectures, workshops, mandatory online training, and a program of multiple simulations, which involved all stakeholders. The workflows were dynamic in that simulation exposed occasional unintended consequences of initially planned workflows, resulting in appropriate and workable adaptations to workflows. Extensive discussions and multiple simulations for nearly a year before opening the NICU were undertaken before final guidelines were agreed upon by all stakeholders.

On opening the NICU to neonatal general surgical patients, weekly multidisciplinary meetings were set up with the surgical team. In addition, weekly meetings were set up with microbiologists, infection control and infectious disease teams, radiology, neuroradiology, and cardiology.

Referral care pathways were also developed for all babies requiring surgery, cardiac or other pediatric specialist support, within a "Qatar Perinatal Network." This required close liaison with the leadership team of the other maternity and neonatal units in Qatar, specifically those within the Hamad Medical Corporation (HMC), the primary Government health care provider in Qatar. It was agreed that women known to be carrying babies with antenatally detected abnormalities requiring postnatal intervention should be referred to antenatally and give birth at Sidra Medicine. The referral system closely involved the Qatar Neonatal Transport service, hosted by the HMC, and capacity management services at Sidra, whereby a single phone number was to be called to make a referral.

Review of outcomes

A review was conducted of all babies below four weeks corrected age who underwent surgery from 1st of April 2018 – 31st of March 2020. The gestational age, birth weight, the primary diagnosis, the surgical procedures, the 30-day postoperative mortality, overall mortality, and cause of death was recorded.

RESULTS

One hundred and sixty-nine babies (169) were admitted into the Neonatal Intensive Care Unit of Sidra Medicine between the 1st of April 2018 and the 31st of March 2020 and underwent general surgical procedures under general anesthesia. Seventy-five babies (44.4%) were term, while 94 babies (55.6%) were preterm (born before 37 weeks gestation). Of the preterm babies, 29 were between the gestational ages of 34 – 36+6 weeks; 47 were born between 28 – 33+6 weeks; 15 were born between 25 – 27+6 weeks, and three babies were born between 23 – 24+6 weeks gestation.

Table 1: Types of primary procedures performed and frequency.

Type of Primary Surgical Procedures	Frequency
Laparotomy	76
Surgery for Anorectal Malformation	25
Inguinal Herniotomy	24 (12 Bilateral)
Congenital Diaphragmatic Hernia repair	20 (8 thoracoscopic)
Esophageal Atresia repair	13 (3 thoracoscopic) – 1 had duodenal atresia
Laparoscopic Fundoplication	3
Sacrococcygeal teratoma excision	2
Gastrostomy insertion	2
Diagnostic Laparoscopy	1
Laparoscopic Ovarian Cyst Deroofing	1
Diagnostic Thoracotomy	1
Open Rectal Biopsy	1
Circumcision	1

The mean weight of the babies was 2188g, and the median was 2305g (range: 643 to 4990g). Birth weights of 26 babies were less than 1000g; 24 babies weighed 1000-1500g, 25 babies weighed 1500-2000g, and 93 babies weighed >2000g.

Surgery performed

Primary surgery was classified into thirteen types of procedures, as shown in Table 1.

All minimally invasive procedures were undertaken within the second year of operations.

The primary diagnosis leading to laparotomy is shown in Table 2.

Table 2: Primary diagnosis in babies undergoing Laparotomy.

Primary Diagnosis	Frequency
Necrotizing enterocolitis	27
Malrotation	8 (7 with midgut volvulus)
Meconium ileus	7
Abdominal wall defects	5 (2 gastroschises and 3 Exomphalos)
Gastric perforations	4 (one also had Necrotizing enterocolitis)
Spontaneous ileal perforations	4
Jejunal atresia	4
Duodenal atresia	4
Ileal atresia	3
Open excision of ovarian cyst	3
Hirschsprung's disease (pull-through)	2
Conjoined Twins	One set (2 babies successfully separated)
Pyloric atresia	1
Urachal remnant	1
Colostomy for perineal ecthyma gangrenosum	1
Nephrectomy for mesoblastic nephroma	1

Mortality

Fourteen babies died, resulting in overall mortality of 8.3 %. Out of these, ten babies died in the first year of the service. Eight out of the 14 babies had multiple congenital anomalies, which were life-limiting. None of these eight children died from complications related to surgery. Excluding these eight children, overall postoperative surgical mortality was 3.6% (6/169).

Of the remaining six babies, three died from sepsis and two due to severe pulmonary hypertension. One baby died two months after discharge from unknown causes. Excluding babies who died due to life-limiting conditions, two babies died within 30 days of surgery, resulting in a neonatal surgical mortality rate at 30 days postoperatively of 1.2 % (2/169). Table 3 summarizes the demographics, diagnosis, and cause of death of all fourteen babies.

DISCUSSION

Neonatal general surgical mortality has significantly improved globally in the last three decades.[1-3] Advancements in neonatal intensive care, anesthesia, nursing, and medical technology have transformed the outcomes in all babies, including preterm babies. Overall mortality now stands at less than 10% in the top-performing centers internationally.[2] Unfortunately, the same cannot be stated for developing countries where lack of resources remains the major cause of the high levels of neonatal mortality rather than the healthcare staff's actual skill.[4]

The neonatal general surgical service at Sidra Medicine was developed in a brand-new estate and with a workforce from multiple different backgrounds, bringing multiple different working practices and much expertise. There was a "tabula rasa" – a blank sheet on which to develop and establish a new, high-quality clinical service, which may have been a strength of the initiative. While many within the workforce had delivered services in different ways in top institutions, all the stakeholders had a common goal and agreed that a consistent approach to care delivery would be in the best interests of the patients and their families. Several conflict areas did occur, but these were dealt with professionally, keeping the overall focus on the best treatment modalities for the babies. Initial institutional funding allowed the recruitment of a workforce with a strong training background, expertise, and experience.

Simulation played an essential role in learning from other colleagues; irrespective of seniority, NICU and surgical staff were always open to learning from each other, which enabled a conducive forum to share ideas positively and facilitate high-quality management.

Outpatient clinics (especially surgery and the High-Risk Infant Follow-up clinics) were instrumental in securing long-term good individual outcomes. Excellent support was also received from the division of pediatric infectious diseases and infection control in selecting appropriate antibiotic and anti-fungal regimens and supporting antibiotic stewardship.

During the two years covered by this paper, the funding of the neonatal surgical services was largely centrally through government funding which allowed all children to be treated according to their needs. We believe that this was a major contributory factor to the excellent outcomes and the overall low mortality. Babies from all socio-economic backgrounds, including babies of low-income families and refugees from war zones, were not adversely affected by the financial status of their guardians.[5,6]

The relationship between the neonatal surgeons and the neonatologists was particularly close, with every attempt to avoid working in silos. In many neonatal surgical services in the Western world, the pediatric surgeons operate and may hand over care to the neo-

natologists, with liaison via regular multidisciplinary team meetings. We felt that this was not the best pattern in an immature system where staff was not adjusted to working with each other. Hence in addition to the weekly multidisciplinary meetings, daily ward rounds were conducted by the surgeons and neonatologists together with daily briefings. The close-knit relationship was further enhanced through a written protocol that emphasized that no "elective" decisions should be taken on managing any baby without both the neonatologists and the neonatal surgeons in agreement. These specifically included nutritional requirements, including parenteral and enteral nutrition for babies with intestinal failure, feeds, and increasing feeds. In congenital diaphragmatic hernia babies, the timing of surgery, elective extubation, and decisions regarding starting ECMO or weaning off ECMO were taken jointly. Management decisions were agreed upon at the weekly meetings, with both teams agreeing if elective changes were required during other parts of the week, which was initially challenging, but the teams quickly recognized the advantages of such a close-knit relationship. In emergency cases, the neonatologists acted immediately in the interests of the baby without having to consult the neonatal surgeons to avoid delays in emergency treatment. Postoperative handover of babies involved anesthesiologists, the neonatal surgeon, neonatologists, and the NICU team in line with best-practice international guidelines, with further modifications to ensure that the multinational team understood the handover process.[7]

Table 3: Mortality, primary diagnosis, demographics, and causes of death (LL –Life-limited).

Primary Diagnosis	Birth weight	Gestational Age	Cause of Death
Gastric Perforation	830g	29^{+3}	Neuronal migration disorder (LL)
Diagnostic Thoracotomy (Negative)	1600g	36	Brain anomalies, IUGR, Respiratory Failure (LL)
Esophageal atresia	2870g	39	Multiple anomalies (LL)
Necrotizing enterocolitis	2060g	31^{+4}	Hypoventilation syndrome, seizures, ASD, Pseudo-TORCH Syndrome (LL)
Esophageal atresia, VACTER, Duodenal Atresia	1410g	31^{+1}	Renal failure; Truncus arteriosus (unrepaired) – LL
Congenital Diaphragmatic Hernia	2450g	38	Trisomy 13; Profound apnoea (LL)
Gastric Perforation	830g	29^{+3}	Renal failure, Pulmonary hypertension, suspected mitochondrial disorder (LL)
Necrotizing enterocolitis	1370g	32^{+4}	Congenital short bowel syndrome; choledochal cyst; Respiratory failure, Trisomy 16 (LL)
Esophageal atresia, VACTERL, Duodenal atresia, IUGR	1760g	38	Sepsis
Spontaneous Ileal Perforation; IUGR	750g	31	Severe pulmonary hypertension with cardiac failure;
Congenital diaphragmatic hernia; cleft palate; IUGR	1400g	32^{+4}	Hypoplastic cerebellum, Ventilator-associated pneumonia, severe pulmonary hypertension; sepsis
Gastric Perforation	Unrecorded	28	Sepsis
Congenital Diaphragmatic Hernia	2340g	36^{+4}	Died two months after discharge of unknown cause
Sudden overwhelming sepsis – Laparotomy to decompress abdomen showed pan-enteric pneumatosis (? Secondary NEC to Sepsis)	750g	25	Overwhelming Sepsis

We believe that the strong collaboration on nutritional management of surgical babies between surgeons, neonatologists, and allied health care professionals contributed significantly to the low mortality in babies with intestinal failure, necessitating prolonged dependence on parenteral nutrition babies with short bowel syndrome and following necrotizing enterocolitis. International guidelines such as the ESPGHAN guidelines were initially proposed as the foundation for these babies' nutritional decisions. The combined high-level multinational expertise within the unit allowed for tailoring nutritional requirements for individual babies, ensuring hepatoprotection through a program of lipid restriction and prompt treatment of infection.[8]

Sidra NICU is staffed by about 180 nurses from various countries worldwide, most of whom had not worked either in the Middle East or even with each other. Nursing leadership was paramount in ensuring continuous and adequate training in the clinical aspects of intensive care and understanding the different cultures regarding the parents of the babies and the different expectations therein. By international standards, we believe that the adequate staffing of the unit was a significant necessity for excellent outcomes.[9]

Prematurity and low birth weight play a significant role in the outcomes of neonatal surgery.[10,11] More than half of the patients in this report were preterm

babies. Eleven out of 14 babies who died were preterm babies. However, it must be noted that 8 of 14 children had life-limiting conditions. Of the six remaining babies, five were preterm babies. Hence, excluding the six preterm babies with life-limiting conditions, the overall mortality of preterm babies undergoing surgery in the two years was 5 out of 88 babies or 5.7%, comparable with international outcomes in advanced countries.

CONCLUSION

We believe that many factors contributed to the excellent outcomes of neonatal surgical cases in the State of Qatar in the first two years of starting the first state–of–the–art Children's hospital in the country. These included a shared vision of achieving excellence, good teamwork, effective frontline leadership, adequate nursing, sufficient funding for the estate and equipment, high-level clinical expertise, and meticulous preparations before opening the service. We believe these are the first published national results of neonatal general surgical cases in the Gulf region. Long-term follow–up of patients and regular yearly audits will be needed to assess the sustainability of these results.

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REFERENCES

1. Yagi M, Kohno M, Asagiri K, Ikeda T, Okada T, Kanada S, et al. Twenty-year trends in neonatal surgery based on a nationwide Japanese surveillance program. Pediatr Surg Int. 2015; 31:955-62. Available from: https:// doi.org/10.1007/s00383-015-3775-z.
2. Taguchi T. Current progress in neonatal surgery. Surg Today. 2008; 38: 379–89. Available from: https:// doi.org/10.1007/s00595-007-3657-7.
3. Tauro JK, Walker K, Halliday R, Jatana V, Trivedi A. Trends in mortality in an Australian tertiary surgical neonatal intensive care unit. J Neonatal Surg. 2018; 7. Available from: https://doi.org/10.21699/jns.v7i1.677.
4. Saggers RT, Ballot DE, Grieve A. An analysis of neonates with surgical diagnoses admitted to the neonatal intensive care unit at Charlotte Maxeke Johannesburg Academic Hospital, South Africa. S Afr Med J. 2020; 110:497–501.
5. Flynn-O'Brien KT, Richards MK, Wright DR, Rivara FP, Haaland W, Thompson L, et al. Health outcomes and the health care and societal cost of optimizing pediatric surgical care in the United States. J Pediatr Surg. 2019; 54: 621–7. Available from: https://doi.org/ 10.1016/j.jpedsurg.2018.10.102.
6. Stone ML, LaPar DJ, Mulloy DP, Rasmussen SK, Kane BJ, McGahren ED, et al. Primary payer status is significantly associated with postoperative mortality, morbidity and Hospital Resource Utilization in Pediatric surgical patients within the United States. J Pediatr Surg, 2013; 48:81–7. Available from: https:// doi.org/ 10.1016/j.jpedsurg.2012.10.021.
7. France DJ, Slagle J, Schremp E, Moroz S, Hatch LD, Grubb P, et al. Impact of patient handover structure on neonatal perioperative safety. J Perinatol. 2019; 39:453–7. Available from: https://doi.org/10.1038 /s41372-018-0305-6.
8. Bhatt D, Travers C, Patel RM, Shinnick J, Arps K, Keene S, et al. Predicting mortality or intestinal failure in infants with surgical necrotizing enterocolitis. J Pediatr. 2017; 191:22–7. Available from: https:// doi.org/10.1016/j.jpeds.2017.08.046.
9. Rogowski JA, Staiger DO, Patrick TE, Horbar JD, Kenny MJ, Lake ET. Nurse staffing in neonatal intensive care units in the United States. Res Nurs Health. 2015; 38:333–41. Available from: https://doi.org/10.1002 /nur.21674.
10. Glass HC, Costarino AT, Stayer SA, Brett C, Cladis F, Davis PJ. Outcomes for extremely premature infants. Anesth Analg. 2015; 120:1337–51. Available from: https://doi.org/10.1213/ANE.0000000000000705.
11. Skertich NJ, Ingram ME, Ritz E, Shah AN, Raval MV. The influence of prematurity on neonatal surgical morbidity and mortality. J Pediatr Surg. 2020; 55:2608-13. Available from: https://doi.org/10.1016/j.jpedsurg .2020.03.024.