



## In Situ Surgery: Is It Safe ? (Experience with 60 cases)

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**Background/Purpose:** Neonatal surgical unit (NSU) is the area of a hospital where sick babies having surgical problem go once they are born. Performing in-situ surgery (ISS) in the NSU is relatively a new concept that is gaining popularity in the last decade. Critically ill neonates who are too ill to transfer to the operating room can undergo safe surgery in the NSU environment of a fully-equipped pediatric hospital. Transfer of the critically ill neonates is time consuming, utilizing manpower and requiring suitable portable ventilators and extensive monitoring equipments.

**Materials & Methods:** This is a prospective study conducted on 60 neonates admitted in the surgical neonatal unit of the Cairo University pediatric hospital (Abou-Elrishi) and where subjected to surgical procedures in the unit itself. The patients were categorized into 3 groups: The First group was the group at the beginning of the study for which minor procedures were selected. The second group was those neonates that were operated upon on emergency base for which transfer could be hazardous. The last group included those patients on high settings of ventilation and critically ill neonates with extensive monitoring.

**Results:** There was no mortality in the study related to the procedures itself. Group I patients: the time of the surgical procedures was longer than that in the OR and no increase in the infection rate was noticed. Group II in which emergency procedures were carried on showed also increase in operating time but better perioperative circumstances regarding secondary insult to viable structures & less infection rate. Group III: no significant change in outcome in comparison to cases transferred to OR except that the perioperative circumstances were better for the surgeon, anesthesiologist & nursing teams.

**Conclusion:** NSU is a safe place for performing in-situ surgery (ISS) without increased risk of infection. Successful operative intervention within NSU requires good planning and cooperation between anesthesiologist, surgeons, neonatologist and nursing staff. Maximum benefit is observed in neonates who have definite risk attached to transfer to operating room.

**Index Word:** In-Situ Surgery (ISS) – Neonatal Surgical Unit (NSU).

### INTRODUCTION

In-situ surgery (ISS) in the NSU means that neonates who require surgery can be operated upon in specially designed area within the NSU without being transferred to the classic operation room (OR) with its associated hazards. Performing in-situ surgery in the NSU is relatively a new concept that is gaining popularity in the last decade. Although many previous reports have shown that many types

of surgical procedures can be done safely as ISS in the NSU, there remains reluctance to use.<sup>1,2</sup>

Neonates who are critically ill to be transferred to the OR may undergo safe surgery in the NSU on a condition that the unit is fully-equipped. Transfer of the critically ill neonates is time-consuming, utilizing manpower and requiring suitable portable ventilators

and extensive monitoring equipments. ISS avoids the potentiality of line disconnection or endotracheal tube dislodgement. It also guards against hypothermia & general decomposition.<sup>3,4</sup>

The journey back from the OR can be particularly hazardous since the baby is often more fragile immediately after surgery. Emergencies such as hemorrhage, arrhythmias, displaced endotracheal tube or pneumothorax can usually be managed very well in a closely monitored baby on the NSU but can be a nightmare in a transport incubator being wheeled along the corridor or in an elevator between floors. In view of these considerations some pediatric surgical centers have utilized NSU as an alternative place to carryout surgery in critically ill neonates aiming to reduce morbidity.<sup>5</sup>

## PATIENTS AND METHODS

This is a prospective study carried on the Pediatric Hospital of Cairo university (Abo-Elrish) in the Neonatal Surgical Unit (NSU). NSU has capacity of 34 incubators which is fully monitored with each incubator having a separate gas supply & suction source with an available area of 4 meter square for each. The unit has availability of treatment with phototherapy, Nitric Oxide & ECMO. The unit has its own surgical instrument sets with availability of sterilization. Neonates were operated upon inside an open incubator with a radiant warmer. The incubator was placed inside a room that provides easy accessibility to the patients as well as satisfactory level of sterilization and infection control. Wall partitions partly made of glass to allow external observation isolate the operation site. The staff working in the unit were wearing masks & caps; the operating team were wearing surgical aprons & gloves.

Surgical & anesthetic equipments were prepared and rechecked prior to surgery. Anesthesia workstation used was Dragger Julian (Cato version) with attached monitor containing noninvasive blood pressure (NIBP) and invasive blood pressure (IBP), pulse oximetry, peripheral & core temperature probe and capnography.

Magnifying loops and over head light sources are very helpful during procedures in NSU.

Anesthesia was tailored according to the case but in general all neonates were intubated to secure airways & either inhalational techniques using sevoflourane +

oxygen/air (50/50)+ rocuronium +fentanyl or total intravenous technique (TIVA) either by ketamine +oxygen/air (50/50)+ rocuronium or another protocol using midazolam+oxygen/air(50/50)+ remifentanyl + rocuronium.

The study was conducted between 2005 and 2009, on 60 neonates admitted to the unit with various pathologies where written informed consent from parents was obtained. The patients were allocated into three groups: group I: Included 30 cases, 10 cases with exomphalos minor for whom direct closure was done (2 cases needed Ladd operation for accompanied malrotation ), 5 cases with unilateral oblique inguinal hernias that needed herniotomy, 6 cases with Idiopathic hypertrophic pyloric stenosis for whom Ramsted operation was done( those cases were admitted before one month of age), 8 cases for central venous line insertion and one case with bilateral choanal atresia for whom blunt perforation was done.

Group II: included 15 patients that were done on an emergency basis: 8 cases with gastroschisis(3 were closed by skin flaps &5needed silo), 3 cases with rupture sac of exomphalos ( were closed with skin flaps ), one case with rupture myelomeningocele (closed by lumbar fascia flaps), one case with obstructed airway from pedicled teratoma from skullbase in a patient with cleft palate that suddenly increased in size & needed transfixion & excision for obstructing the airway, 2 cases with necrotizing enterocolitis that needed urgent laparotomy for pneumoperitoneum compromising their respiration & causing splinting of diaphragm,exploration revealed single ileal perforation with otherwise healthy bowel for which freshening of the edge with primary closure & insertion of intraperitoneal drain in one case ,the other showed 3 perforations with compromised bowel vascularity in the intervening segments primary closure with intraperitoneal drainage , this case needed later on exploration for continuous faeculent discharge coming from drain.

Group III: included 15 cases, 6 of them needed insertion of central venous lines in ventilated neonates, 3 others had diaphragmatic hernia with high ventilatory settings & pulmonary hypertension above 40 mmHg (reduction of contents through left subcostal incision with closure of left diaphragmatic defect), 2 cases with oesophageal atresia & distal tracheo-oesophageal fistula with progressive abdominal distention due to wide fistula and deteriorating respiratory functions, that needed urgent intubation and gastrostomy with transfixion of cardia of stomach to close the fistulous track with

oesophagostomy for the proximal pouch(thoracotomies were avoided ,the concept of trying to correct the derangement with the least invasive manoeuvre was followed besides lateral position is difficult on incubator )Three cases suffered from burst abdomen and needed urgent reduction of contents with retention sutures. One case needed colostomy for high imperforate anus in a case with Down's syndrome & cyanotic heart disease.

## RESULTS

The study was conducted on 60 cases operated upon on in the NSU. There was no postoperative mortality in the study, no case needed urgent transfer from the NSU to the OR due to surgical circumstances. Group I included 30 patients done early in this study, for which minor procedures were undertaken to minimize perioperative risks, there was no clinical signs of infection post operatively except for one case of idiopathic hypertrophic pyloric stenosis (3.3%) that showed incomplete skin dehiscence for which conservative measures were undertaken till complete healing. The mean operative time for the surgical procedures took longer time (nearly double the usual time in the beginning of the study). Then operating time decreased gradually as the surgeons, anesthetists & nursing staff got accustomed to the operating circumstances.

In group II (15 cases), the cases were candidates for operations on NSU on emergency basis, no perioperative mortality occurred; infection was noticed in the wounds in 3 cases (20%). Operating time was longer than that in OR(records of operating time for operations done frequently are available ,also time consumed in preparation of the incubator to be transferred with the trip to and from the OR )

In group III (15 cases), the neonates had comorbid conditions that necessitated doing the procedures in the NSU to eliminate the risks of transfer, no perioperative mortality, 2 cases with proximal esophageal atresia and distal tracheoesophageal fistula had progressive bradycardia that needed intubation & mechanical ventilation but did not improve much until decompression of the stomach & transfixion of the cardia, both cases recovered & remained on CPAP postoperatively(the cases were diagnosed as respiratory distress type 3 & their initial arterial blood gases values had improved on CPAP then deterioration was attributed to progressive air

leak to gut & splinting of diaphragm) one of them showed deterioration of renal functions that needed renal support. Catheter associated sepsis with positive blood cultures was noticed in 2 cases (13.4%). The overall complications in the 60 patients were noticed in 8 cases (12.5%).

Infection was noticed in 5 cases (8.3%). The percentage of complications was presented in each group individually due to separate circumstances in each group

## DISCUSSION

Performing in-situ surgery (ISS) in the NSU is relatively a new concept that is gaining popularity in the last decade and the procedure has a root from the ICU for adults as performing some urgent procedures in the ICU known as damage control surgeries in the form of releasing compartmental syndrome of the abdomen and control of bleeding from a bleeding organ as packing of liver.

The studies that support the safety of ISS declare that the outcome is not influenced by the site of surgery, but rather by the severity of the comorbid condition of the patient.<sup>5,6,7</sup>

Although theatre staff is required for ISS, this is considerably less demanding than accommodating emergency cases in a busy operation room. ISS further facilitate continuity of care, allowing the same nursing, intensivist & anesthetic teams to care for the patient through all phases of their NSU stay.<sup>4</sup> ISS requires the constant back-up of a fully staffed & equipped OR to meet the significant and often unforeseen demands of surgery. Typically, a circulating nurse will make several excursions to the OR during an ISS procedure. Provision of a fully-stocked mobile supply may overcome this problem.<sup>4</sup> The time is still early to gain solid data to assess the pros and cons of the procedure, however, it is valuable to discuss some studies that dealt with the concept of ISS. Eggert et al studied 79 consecutive patent ductus arteriosus (PDA) ligations performed in NSU over a four years period. Seven infants (9%) died within one month after surgery. The deaths were not attributed to the surgery but were associated with preexisting medical complications or new intracranial hemorrhages. Significant surgical morbidity was rare and they concluded that ligation of PDA in the premature can be a safe & effective procedures when pharmacological closure is ineffective or contraindicated. Furthermore PDA ligation may be

safely performed in the NSU.<sup>8</sup>

In a retrospective study done by Coster et al including 115 sequential PDA surgical closures performed in NSU in premature infants, they found no surgical morbidity or mortality, they concluded that surgical closure of symptomatic PDA in NSU eliminates transport risks and is ultimately safer & easier than transport to an operating room.<sup>2</sup>

Gavilanes et al performed a retrospective study to evaluate the advantages, disadvantages and short term morbidity & mortality of major surgical interventions performed in the NSU. The indications of surgery were ligation of PDA (n=16); insertion of a subcutaneous ventricular catheter reservoir for hydrocephalus (n=14); repair of congenital diaphragmatic hernia (n=2); open lung biopsy (n=1); and laparotomies because of necrotizing enterocolitis, anorectal malformations and intestinal obstructions (n=12). The management of these neonates at laparotomy was bowel resection with stomas (n=8) and stomas (n=4). No special designed area was used to perform surgeries. Local or systemic infection associated with surgery was not seen and no perioperative mortality was related to the surgical procedures.<sup>3</sup>

In our study there was no perioperative mortality, in most of the procedures done the operating time was longer however transporting time from and to the OR was not calculated in comparing. The overall complications were noticed in 8 cases (12.5%) and infection was reported in 5 cases (8.3%). In a study done by Lally et al<sup>9</sup> they reported no difference in catheter-associated sepsis with positive blood culture when comparing central venous catheter insertion in the OR (20%) and the NSU (19%). The NSU catheters were in place for an average of 51 days and there was an average 46 day life span for the OR inserted catheters. The concern that ISS is associated with higher incidence of infection than the OR surgery is disproven by many studies. Several authors have demonstrated no increase in catheter associated or wound infections following ISS.<sup>9,10,11,12</sup>

Chris et al performed a comparative analysis of shunt placement in the NSU and the OR, 17 neonates with posthemorrhagic hydrocephalus were treated with ventriculosubgaleal shunt (VSG) placement over a period of 4 years. No differences in perioperative or intraoperative risks & no increased risk of infection were seen in this pilot study.<sup>12</sup>

On the other side, a study was conducted on 42

neonates, comparing between congenital diaphragmatic hernia (CDH) patients that underwent surgery in the NSU (n=18) and in the OR (n=24). In this series, the NSU group had more infectious complications. The 18 patients operated upon in the NSU were critically ill on High frequency oscillatory ventilation (HFOV) and unsuitable to transfer to OR. The survival rate of uncomplicated CDH was 78% and a low rate of chronic lung disease was reported.<sup>13</sup>

## CONCLUSION

NSU is a safe place for performing in-situ surgery (ISS) without increased risk of infection. Successful development of surgery within NSU requires good planning and cooperation between anesthesiologist, surgeons, neonatologists, NSU and OR nursing staffs. Surgery can be performed without much difficulty by the bedside designated area which can be used for surgery. No disturbance to routine NSU work. Performing major surgical neonatal procedures in NSU is both feasible & safe. Maximum benefit is observed in neonates who have definite risk attached to transfer to operating room.

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