Ambulance Service Associated With Reduced Probabilities Of Neonatal And Infant Mortality In Two Indian States

Online Appendix

Appendix Exhibit 1: GVK EMRI Service Rollout
### Appendix Exhibit 2: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Andhra Pradesh</th>
<th>Gujarat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study Period</strong></td>
<td>2004-2008</td>
<td>2004-2010</td>
</tr>
<tr>
<td><strong>EMRI Service Intensity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambulances per Million</td>
<td>0.16</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>(.003)</td>
<td>(.004)</td>
</tr>
<tr>
<td><strong>Infant and Maternal Health Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infant mortality</td>
<td>37 per 1000</td>
<td>10 Per 1000</td>
</tr>
<tr>
<td></td>
<td>(2.597)</td>
<td>(1.091)</td>
</tr>
<tr>
<td>Neonatal Mortality</td>
<td>25 per 1000</td>
<td>8 per 1000</td>
</tr>
<tr>
<td></td>
<td>(2.070)</td>
<td>(0.961)</td>
</tr>
<tr>
<td>Complications</td>
<td>45.1%</td>
<td>36.3%</td>
</tr>
<tr>
<td></td>
<td>(0.864)</td>
<td></td>
</tr>
<tr>
<td><strong>Delivery Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Deliveries</td>
<td>71.4%</td>
<td>65.3%</td>
</tr>
<tr>
<td></td>
<td>(0.940)</td>
<td>(1.498)</td>
</tr>
<tr>
<td>Attended Deliveries</td>
<td>75.5%</td>
<td>69.6%</td>
</tr>
<tr>
<td></td>
<td>(0.908)</td>
<td>(1.390)</td>
</tr>
<tr>
<td>Any Expenditure</td>
<td>91.2%</td>
<td>86.7%</td>
</tr>
<tr>
<td></td>
<td>(0.554)</td>
<td>(0.787)</td>
</tr>
<tr>
<td>Expenditure (Rupees)</td>
<td>6,220</td>
<td>2,799</td>
</tr>
<tr>
<td></td>
<td>(143.87)</td>
<td>(115.48)</td>
</tr>
<tr>
<td>Transport Expenditure (Rupees)</td>
<td>187</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.631)</td>
<td></td>
</tr>
<tr>
<td><strong>Socio-economic Characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at Marriage</td>
<td>17.35</td>
<td>18.27</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Age at Delivery</td>
<td>22.04</td>
<td>24.52</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.092)</td>
</tr>
<tr>
<td>% Illiterate</td>
<td>40.5%</td>
<td>46.2%</td>
</tr>
<tr>
<td></td>
<td>(0.984)</td>
<td>(1.285)</td>
</tr>
<tr>
<td>% Hindu</td>
<td>84.5%</td>
<td>93.9%</td>
</tr>
<tr>
<td></td>
<td>(0.795)</td>
<td>(0.767)</td>
</tr>
<tr>
<td>% Scheduled Tribe or Other Backward Class*</td>
<td>83%</td>
<td>82.5%</td>
</tr>
<tr>
<td></td>
<td>(0.726)</td>
<td>(1.421)</td>
</tr>
<tr>
<td>Rural</td>
<td>75.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.343)</td>
<td></td>
</tr>
</tbody>
</table>

Weighted sample means provided with linearized standard errors in parentheses. Source: District Level Household Survey 3 (Andhra Pradesh) and COHESIVE Survey (Gujarat). Scheduled Tribes and Other Backward Classes refer to indigenous groups and castes deemed by the Government of India to be socially and economically disadvantaged.
Appendix Exhibit 3: GVK EMRI Service Intensity by District and Month in Andhra Pradesh and Gujarat

EMRI Ambulance Service Intensity: Andhra Pradesh

EMRI Ambulance Service Intensity: Gujarat
## Appendix Exhibit 4: Targeting Analysis

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Infant Death (Prior to 12 Months Old)</th>
<th>Neonatal Death (Prior to 28 Days Old)</th>
<th>Infant Death (Prior to 12 Months Old)</th>
<th>Neonatal Death (Prior to 28 Days Old)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AP</td>
<td>Gujarat</td>
<td>AP</td>
<td>Gujarat</td>
</tr>
<tr>
<td>Ambulances per 1M population</td>
<td>-0.0637**</td>
<td>-0.0025</td>
<td>-0.0449*</td>
<td>-0.0027</td>
</tr>
<tr>
<td></td>
<td>[-0.1258 - -0.0016]</td>
<td>[-0.0131 - 0.0081]</td>
<td>[-0.0972 - 0.0073]</td>
<td>[-0.0125 - 0.0072]</td>
</tr>
<tr>
<td>Indicator for 6 months prior to EMRI rollout</td>
<td>0.0100</td>
<td>0.0019</td>
<td>0.0069</td>
<td>0.0025</td>
</tr>
<tr>
<td></td>
<td>[-0.0109 - 0.0309]</td>
<td>[-0.0086 - 0.0125]</td>
<td>[-0.0102 - 0.0239]</td>
<td>[-0.0077 - 0.0128]</td>
</tr>
<tr>
<td>Indicator for 6 months prior to EMRI rollout* Peak EMRI service intensity</td>
<td>-0.0120</td>
<td>-0.0071</td>
<td>0.0190</td>
<td>-0.0082</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0381</td>
<td>0.0084</td>
<td>0.0278</td>
<td>0.0049</td>
</tr>
<tr>
<td></td>
<td>[-0.0307 - 0.1069]</td>
<td>[-0.0204 - 0.0371]</td>
<td>[-0.0355 - 0.0911]</td>
<td>[-0.0196 - 0.0293]</td>
</tr>
<tr>
<td>Observations</td>
<td>6,765</td>
<td>9,392</td>
<td>6,765</td>
<td>9,392</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.0267</td>
<td>0.0197</td>
<td>0.0234</td>
<td>0.0214</td>
</tr>
</tbody>
</table>

Maternal and household controls (mother's education, age at marriage, age at delivery, religion, scheduled tribe or other backward class membership, and household wealth as measured through wealth index quintiles), district fixed effects, year-month fixed effects and district-specific time trends included but not shown. Scheduled Tribes and Other Backward Classes refer to indigenous groups and castes deemed by the Government of India to be socially and economically disadvantaged. 95% confidence intervals shown in brackets. Robust standard errors clustered at the district level. *** p<0.01; ** p<0.05; * p<0.10
Appendix Exhibit 5: Effect of EMRI service intensity on maternal health outcomes by baseline mortality environment - Andhra Pradesh

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>6 Month Mean Pre-EMRI Infant Mortality</td>
<td>-0.0417</td>
<td>-0.0466</td>
<td>-0.0307</td>
<td>-0.0251</td>
<td>-0.0391</td>
<td>-0.0558*</td>
<td>-0.0392</td>
<td>-0.0275</td>
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<tr>
<td>12 Month Mean Pre-EMRI Infant Mortality</td>
<td>[-0.1081 - 0.0247]</td>
<td>[-0.1138 - 0.0207]</td>
<td>[-0.1017 - 0.0404]</td>
<td>[-0.0990 - 0.0488]</td>
<td>[-0.1013 - 0.0232]</td>
<td>[-0.1148 - 0.0033]</td>
<td>[-0.1035 - 0.0251]</td>
<td>[-0.0919 - 0.0369]</td>
</tr>
<tr>
<td>18 Month Mean Pre-EMRI Infant Mortality</td>
<td>-0.4967**</td>
<td>-0.4033</td>
<td>-0.7144*</td>
<td>-0.8209*</td>
<td>-0.1960</td>
<td>0.2679</td>
<td>-0.2020</td>
<td>-0.5626</td>
</tr>
<tr>
<td>24 Month Mean Pre-EMRI Infant Mortality</td>
<td>[-0.9934 - 0.0001]</td>
<td>[-1.1158 - 0.3091]</td>
<td>[-1.5158 - 0.0869]</td>
<td>[-1.6986 - 0.0569]</td>
<td>[-0.9937 - 0.6016]</td>
<td>[-0.6335 - 1.1694]</td>
<td>[-1.1999 - 0.7959]</td>
<td>[-1.6277 - 0.5025]</td>
</tr>
</tbody>
</table>

Ambulances per 1M population

<table>
<thead>
<tr>
<th>Ambulances per 1M population</th>
<th>Infant Death</th>
<th>Infant Death</th>
<th>Infant Death</th>
<th>Infant Death</th>
<th>Neonatal Death</th>
<th>Neonatal Death</th>
<th>Neonatal Death</th>
<th>Neonatal Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Month Mean Pre-EMRI Neonatal Mortality</td>
<td>-0.0270</td>
<td>0.0269</td>
<td>0.0267</td>
<td>0.0271</td>
<td>0.0233</td>
<td>0.0234</td>
<td>0.0233</td>
<td>0.0235</td>
</tr>
<tr>
<td>12 Month Mean Pre-EMRI Neonatal Mortality</td>
<td>[-0.0260 - 0.0289]</td>
<td>[-0.0330 - 0.0219]</td>
<td>[-0.0350 - 0.0239]</td>
<td>[-0.0370 - 0.0259]</td>
<td>[-0.0380 - 0.0269]</td>
<td>[-0.0390 - 0.0279]</td>
<td>[-0.0400 - 0.0289]</td>
<td>[-0.0410 - 0.0299]</td>
</tr>
<tr>
<td>18 Month Mean Pre-EMRI Neonatal Mortality</td>
<td>-0.5626</td>
<td>-0.2020</td>
<td>-0.5626</td>
<td>-0.2020</td>
<td>-0.5626</td>
<td>-0.2020</td>
<td>-0.5626</td>
<td>-0.2020</td>
</tr>
<tr>
<td>24 Month Mean Pre-EMRI Neonatal Mortality</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
<td>[-1.6277 - 0.5025]</td>
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</tbody>
</table>

Maternal and household controls (mother’s education, age at marriage, age at delivery, religion, scheduled tribe or other backward class membership, and household wealth as measured through wealth index quintiles), district fixed effects, year-month fixed effects and district-specific time trends included but not shown. Full results available upon request. Scheduled Tribes and Other Backward Classes refer to indigenous groups and castes deemed by the Government of India to be socially and economically disadvantaged. 95% confidence intervals shown in brackets. Robust standard errors clustered at the district level. *** p<0.01, ** p<0.05, * p<0.10.
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambulances per 1M population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-EMRI Infant Mortality</td>
<td>-0.022</td>
<td>-0.023</td>
<td>0.0114</td>
<td>0.0130</td>
<td>-0.0033</td>
<td>-0.0028</td>
<td>0.0105</td>
<td>0.0092</td>
</tr>
<tr>
<td></td>
<td>[-0.0140 - -0.0096]</td>
<td>[-0.0141 - -0.0095]</td>
<td>[-0.0036 - 0.0264]</td>
<td>[-0.0029 - 0.0290]</td>
<td>[-0.0144 - 0.0077]</td>
<td>[-0.0139 - 0.0082]</td>
<td>[-0.0044 - 0.0253]</td>
<td>[-0.0053 - 0.0237]</td>
</tr>
<tr>
<td>Pre-EMRI Neonatal Mortality</td>
<td>-0.3221***</td>
<td>-0.5360**</td>
<td>-0.9571***</td>
<td>-0.8751***</td>
<td>-0.3233***</td>
<td>-0.6801***</td>
<td>-0.9654***</td>
<td>-0.8471***</td>
</tr>
<tr>
<td></td>
<td>[-0.5293 - -0.1149]</td>
<td>[-0.9422 - -0.1297]</td>
<td>[-1.4729 - -0.4414]</td>
<td>[-1.3372 - -0.4129]</td>
<td>[-0.5385 - -0.1081]</td>
<td>[-1.1528 - -0.2074]</td>
<td>[-1.5661 - -0.3647]</td>
<td>[-1.3711 - -0.3231]</td>
</tr>
<tr>
<td>N</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
<td>9,392</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.0201</td>
<td>0.0205</td>
<td>0.0215</td>
<td>0.0217</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Maternal and household controls (mother's education, age at marriage, age at delivery, religion, scheduled tribe or other backward class membership, and household wealth as measured through wealth index quintiles), district fixed effects, year-month fixed effects and district-specific time trends included but not shown. Full results available upon request. Scheduled Tribes and Other Backward Classes refer to indigenous groups and castes deemed by the Government of India to be socially and economically disadvantaged. 95% confidence intervals shown in brackets. Robust standard errors clustered at the district level. *** p<0.01, ** p<0.05, * p<0.10.
Appendix Exhibit 7: Protocols for Maternal and Neonatal Related Emergencies: Summary Excerpts from Full Emergency Treatment Protocols

Since 2005, faculty from Stanford University's Department of Emergency Medicine have assisted GVK EMRI in an advisory capacity, providing recommendations and guidance with regards to operations, research and training. In 2007, Stanford faculty, in conjunction with GVK EMRI, developed a paramedic training institute, providing training for the first class of paramedics as well as a team of locally-based paramedic instructors. Since 2009, Stanford University physicians have developed training materials for both EMTs and paramedics, including standardized emergency management protocols focused on the treatment of a variety of medical emergencies, including neonatal and obstetric emergencies. These evidence-based guidelines have provided high quality and up-to-date standards of prehospital emergency care. In addition to developing such protocols and instructional materials, Stanford University Emergency Medicine physicians periodically travel to GVK EMRI training centers to conduct seminars for physicians and refresher courses for EMTs. Stanford University has no role in the daily operations, call center activity or organizational strategy. Samples of protocols developed for maternal and neonatal related emergencies are provided below.
CHILDBIRTH (Uncomplicated/Complicated)

Key points
- Symptoms: Abdominal/back pain, vaginal bleeding/push of fluid, minutes between contractions
- History of current pregnancy: Antepartum care, estimated gestational age, complications
- OR history: Number of pregnancies and c-sections, prior complications during pregnancy
- Physical exam: Inspecting external vaginal area for crowning/presenting part if patient feels like she wants to push or if she feels there is something protruding from her vagina
- **DO NOT** pull/push baby

Serious signs and symptoms
- Part other than head presenting from vagina (arm, leg, umbilical cord)
- Excessive maternal bleeding
- Prolonged contractions (>6 contractions in 10 minutes or duration >2 minutes)
- Shortness of breath
- Altered mental status

**Routine medical care**

- **Breech**
- **Limb Presentation**
- **Prolapsed Cord**
- **Shoulder Dystocia**

- Yes: CONTACT ERC PHYSICIAN

  See appropriate care protocol on following pages

- No

  Baby crowning

  Yes: CONTACT ERC PHYSICIAN

  See **Normal delivery protocol** on following page

  - Yes: See **Neonatal resuscitation protocol**

  - Excessive maternal bleeding >500 mL or fully soaked pad

  - No: CONTACT ERC PHYSICIAN

    - 2 large bore IVs
    - 500 mL IV NS bolus, repeat as needed
    - See **Postpartum hemorrhage protocol**

  - Yes: Reassessment and continue transport to maternity hospital

GVK Emergency Management and Research Institute
NEONATAL RESUSCITATION

Definition
- Resuscitation of a newborn to 1 month old

Key points
- Do not take longer than 60 sec to warm, dry, stimulate, clear airway (if obstructed) and begin ventilation (if required)
- Assessment of HR should be done by palpation of the umbilical cord stump or auscultation

Serious signs and symptoms
- Respiratory distress (apnea, gasping, or labored breathing)
- Heart rate <100

Breathing or crying
Good tone
Yes

No

Warm
- Clear airway as needed
- Dry and stimulate

HR <100 bpm, gasping, or apnea
Yes

No

Clamp and cut cord
BMV (check for chest rise)
Check SpO₂, if available

HR <60
Yes

HR >60

Chest compressions
(coordinate 3:1 with BMV)

Target preductal SpO₂ after birth
- 1 min 60-65%
- 2 min 65-70%
- 3 min 70-75%
- 4 min 75-80%
- 5 min 80-85%
- 10 min 85-90%

CONTACT ERC PHYSICIAN
- Adrenaline (1:10,000) 0.01-0.03 mg/kg IV
- Consider repeat dose every 3-5 minutes
- Consider 10 mL/kg IV NS bolus

Yes

Routine Care of Neonate
- Stay with mother
- Provide warmth
- Position, clear airway as needed
- Dry and stimulate
- Clamp and cut cord
- Monitor breathing and HR
- See Childbirth (Post delivery care) protocol

Reassessment and continue transport

GVK Emergency Management and Research Institute
**Preeclampsia/Eclampsia**

**Key Points**
- Preeclampsia and eclampsia can occur from the 20th week of pregnancy until 6 weeks after delivery
- Preeclampsia is a BP >140/90 on >2 readings >6 hours apart AND significant protein in the urine
- Severe preeclampsia signs/symptoms include altered mental status, blurred vision and persistent headache
- Eclampsia is preeclampsia with seizures
- Obtain past medical history: medications, last menstrual period, gestational age (trimester)
- Magnesium toxicity manifests as loss of deep tendon reflexes and respiratory depression

**Differential Diagnosis**
- Epilepsy
- Hypoglycemia
- Trauma/head injury
- Alcohol withdrawal
- Toxins/poisoning/overdose
- Chronic hypertension

**Serious Signs and Symptoms**
- Hypoxia/cyanosis
- Seizures
- Altered mental status
- Shortness of breath

---

**Routine Medical Care**

**Contact ERC Physician**
- Place patient on left side if pregnant
- Oxygen by face mask
- IV access
- Seizure precautions

---

**Seizure ongoing or recent seizure**

Administer BOTH:
- Magnesium sulfate 10 g IM (5 g in each buttock)
- Magnesium sulfate 4 g IV over 10-15 min

- Check blood glucose (GRBS)
- GRBS <80 mg/dL, see Hypoglycemia protocol

- If SBP >160 - OR- DBP >110 mmHg, recheck BP in 10 min and contact ERC physician

**Reassessment and continue transport**
- Seizure precautions

---

**No recent seizure history**

- SBP >160 - OR- DBP >110 mmHg

  **Yes**
  - Recheck BP in 10 min and contact ERC physician

  **If SBP >160 - OR- DBP >110 mmHg, administer BOTH**
  - Magnesium Sulfate 10 g IM (5 g in each buttock)
  - Magnesium Sulfate 4 g IV over 10-15 min

  **No**
  - Shift to maternity hospital
POSTPARTUM HEMORRHAGE (PPH)

Definition
- Greater than 500 mL of blood loss following delivery
- Severe PPH is >1000 mL of blood loss following delivery

Key points
- Most common cause of maternal death in developing nations
- Active management of the third stage of labor can prevent 60% of PPH
- Rapidly evaluate for and correct possible causes
- Uterine atony (soft, boggy uterus) is the most common cause of PPH

Serious signs and symptoms
- SBP <90
- HR >100
- Shortness of breath (RR >30)
- Cool or moist skin
- Altered mental status

Routine medical care

Active management of 3rd stage of labor

>500 mL of blood loss - OR - Serious signs and symptoms

No

Yes

CONTACT ERC PHYSICIAN

- **Oxytocin 20 Units** in 500 mL NS (IV bolus over 20 minutes)
- 2nd IV as needed

Yes

No

Uterus firm

CONTACT ERC PHYSICIAN

- Perform vaginal exam for signs of uterine inversion, lacerations, and ongoing bleeding
- Consider appropriate treatment options

Reassessment and continue transport

Active management of 3rd stage of labor
- Following delivery of all fetuses provide:
  - **Oxytocin 10 Units** IM to mother (Immediately following delivery)
  - Gentle traction on umbilical cord while providing suprapubic pressure (see below)
  - External massage of uterus (see below)

- Bimanual uterine massage
- Continue IV oxytocin infusion
- **Misoprostol 1000 mcg PR AND/OR Methylergonovine 0.2 mg IM** (do not give Methylergonovine if SBP >140 mmHg or known preeclampsia or chronic hypertension)