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**A RETROSPECTIVE EVALUATION OF THE IMPACT OF A DEDICATED  
OBSTETRIC AND NEONATAL TRANSPORT SERVICE ON TRANSPORT  
TIMES WITHIN AN URBAN SETTING**

**Shaheem de Vries (DVRSHA002)**  
MBChB (UCT) Dip PEC (SA)

*SUBMITTED TOWARDS COMPLETION OF THE DEGREE OF MASTER OF PHILOSOPHY,  
EMERGENCY MEDICINE, UNIVERSITY OF CAPE TOWN*

**Declaration:**

I declare that this dissertation is my own unaided work. It is being submitted for Part II of the *degree of Master of Philosophy (Emergency Medicine)* to the Faculty of Health Sciences, University of Cape Town. It has not been submitted before for any degree or examination at any other university.

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Signed this \_\_\_\_\_ day of \_\_\_\_\_ 2009

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## **ABSTRACT**

**Objective:** To determine whether the establishment of a dedicated obstetric and neonatal flying squad resulted in improved performance within the setting of a major metropolitan area.

**Design and Setting:** The Cape Town metropolitan service of the Emergency Medical Services was selected for a retrospective review of the transit times for the newly implemented Flying Squad programme. Data were imported from the Computer Aided Dispatch programme. Dispatch, Response, Mean Transit and Total Pre-hospital times, relating to the obstetric and neonatal incidents was analysed for 2005 and 2008.

**Results:** There was a significant improvement between 2005 and 2008 in all incidents evaluated. Flying Squad dispatch performance improved from 11.7% to 46.6% of all incidents dispatched within 4 minutes ( $p < 0.0001$ ). Response time performance at the 15-minute threshold did not demonstrate a statistically significant improvement ( $p = 0.4..$ ) although the improvement in the 30-minute performance category was statistically significant in both maternity and neonatal incidents. Maternity incidents displayed the greatest improvement with the 30-minute performance increasing from 30.3 % to 72,9%. The analysis of the mean transit times demonstrated that neonatal transfers displayed the longest status time in all but one of the categories. Even so, the introduction of the Flying Squad programme resulted in a reduction in a total pre-hospital time from 298 minutes to 184 minutes.

**Conclusion:** The introduction of the Flying Squad programme has resulted in significant improvement in the transit times of both neonatal and obstetric incidents. In spite of the severe resource constraints facing developing nations, the model employed offers significant gains.

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## GLOSSARY/ABBREVIATIONS

<b>BLS, ILS, ALS</b>	Basic Life Support, Intermediate Life Support, Advanced Life Support.
<b>CAD</b>	Computer Aided Dispatch
<b>ECC</b>	Emergency Control Centre
<b>GEMC<sup>3</sup></b>	Global Emergency Management and Control version 3. This refers to the particular CAD software solution that is currently used in the METRO EMS ECC.
<b>P1</b>	Priority 1 incident refers to a priority grading employed in the ECC and indicates the most urgent category possible.
<b>DISPATCH TIME</b>	Refers to the time that has elapsed from the receipt of the call at the ECC until a vehicle has been assigned the call.
<b>RESPONSE TIME</b>	In the METRO EMS this refers to the time from receipt of the call until an ambulance arrives on scene.
<b>ON-SCENE TIME</b>	Refers to the time that elapses from the arrival of the ambulance on scene until it departs with the patient for the hospital
<b>MISSION TIME</b>	Includes the time that elapsed from receipt of the first call until the ambulance completed the call and reports that it is available.
<b>PRE-HOSPITAL TIME</b>	Defined for the purposes of this study as the time spent from receipt of the call until the ambulance arrives at the hospital.
<b>MATERNITY</b>	A category label which refers to all obstetric incidents as captured on the GEMC <sup>3</sup> .
<b>GIS</b>	Global Information Systems – captures, manages and presents information linked to a location.

## INTRODUCTION

Maternal and child health has been one of the key focus areas expounded upon by the millennium goals. These have formed the basis of national programmes and strategic initiatives of both Government and Non-Governmental Organisations, resulting in an increased awareness of the importance of maternal and child health<sup>[1]</sup>. Whilst many of the initiatives in this regard in the South African health context have largely focused on hospitals (or primary health care and preventative measures), very little has been said of the measures that can be taken by pre-hospital services towards achieving these goals.

### METRO EMS

METRO EMS is a state run service providing essential pre-hospital emergency care to the population of the Western Cape. It serves a total area of 129,526 km<sup>2</sup> with an estimated total population of 5,356,900 people<sup>[2]</sup>. METRO EMS is tasked with the provision of on-scene emergency care and essential medical rescue services, and has a duty to respond to all incidents received by the emergency control centre. It employs nearly 1500 Emergency Care Practitioners (ECP's) personnel with a fleet size of 247 ambulances<sup>[3]</sup>. In addition, an inter-facility transfer service is provided and requests for these are received from health care practitioners located at both government and private health care facilities.

A separate patient transport service (HealthNET) with its own dedicated personnel and vehicles is provided and it focuses on providing non-emergency transport for patients. These patients often have no access to public transport or any other means of getting to their outpatient appointments. The service's emergency control centres are responsible for coordinating and tasking each of these two components.

The service is structured into six districts each with its own management structure and dedicated emergency control centre. The Metropolitan district serves the city of Cape Town and its surrounds and covers a surface area of 2,100 km<sup>2</sup>. It has the largest population of all the districts with 3 500 000 people, the majority of whom (84.3%) reside in the densely built up area of 620 km<sup>2</sup> resulting in an average density of 4,257 people per km<sup>2</sup> [4]. It has a good road infrastructure but a poorly developed public transport system. It has a tiered health care model with different packages of care offered at level 1, level 2 and level 3. It also contains all the tertiary services for the province located at the 3 academic hospitals. The interplay of these factors results in a very high demand for EMS inter-facility transfers and planned patient transport services.

The Metropolitan EMS services are provided by a staff complement of 699 emergency care practitioners with an average operational ambulance fleet of 75 vehicles<sup>[5]</sup>. Practitioners are classified into three levels of medical qualifications. Basic Life Support (BLS), which forms approximately 58.5% of the staff complement; followed by Intermediate Life Support (ILS) constituting 28.0% of the total medical personnel. Advanced Life Support (ALS) practitioners are in the minority and constitute 7.4% of the staff compliment. In addition, EMS also forms part of the emergency medicine rotation that sees two emergency registrars rotate through the service on a 3 month cycle.

Each district has its own emergency control centre, which is equipped with a computer aided dispatch programme. Calls are received at each of the centres from a national medical emergency number, and are directed to trained agents. Patient particulars and essential emergency information are captured electronically before being assigned to the appropriate ambulance by the dispatcher. The dispatcher, who is responsible for updating the vehicle status and for coordinating vehicle movement, monitors all responses. Calls are classified according to the urgency and are assigned a priority grading by the agent. Priority

1 (P1) incidents are regarded as urgent or life threatening (e.g. motor vehicle collision or a suspected myocardial infarction) whilst Priority 2 (P2) incidents are regarded as emergent but not life threatening.

The Metropolitan Emergency Control Centre operates on a 24-hour basis and services calls from both the public as well as from the health care practitioners located at the health facilities across the city. It receives nearly 50 000 calls per month which in turn generates approximately 25 000 incidents <sup>[6]</sup>. Twenty control centre agents staff the centre on average. All agents are trained in the principles of emergency medical dispatch, with several of these possessing pre-hospital medical qualifications. Special incidents, including rescue and major incidents, are managed by a dedicated team of at least one agent and one supervisor.

Performance management is an important aspect of the METRO EMS service with clearly identified targets being set for each of the key indicators. Response time is one such indicator and refers to the time in minutes that has elapsed since the receipt of the call at the control centre, until the arrival of the first ambulance at the address provided. Within the built up communities or urban environments, the target response time is 15 minutes and is currently achieved in 46% of all P1 responses <sup>[3]</sup>. In the more rural settlements, this response target is increased to 40 minutes. Currently, the performance for the rural settlements is being reported as 75% of P1 calls in under 40 minutes. Inter-hospital transfers and rescue services are measured against the same performance targets.

METRO EMS also supports an aeromedical programme. This is provided in partnership with the South African Red Cross Society (S.A.R.C.). The programme is supported by a dedicated staff compliment, augmented by ALS practitioners (paramedics) in the employ of METRO EMS. The programme provides both a rotor-wing as well as a fixed wing service. The rotor-wing programme responds to both primary calls (on the scene) as well as inter-facility

transfers, although the latter represents the bulk of the workload. In addition, both rotor-wing programmes offer a rescue service.

Within METRO EMS, the standard of maternal and neonatal transfers has historically been reported to be poor, with clinicians expressing high levels of frustration at the prolonged response times and ill equipped vehicles.

### **The Obstetric and Neonatal Flying squad**

The Peninsula Maternal and Neonatal Service (PMNS) was introduced in the Western Cape (then Cape Province) in the 1970's as an initiative aimed at reducing the maternal mortality rate within the Cape Province and was the forerunner of the current Community Perinatal Service within the Western Cape. It therefore had at its core the concept of a regionalised perinatal service that would ensure that all births would occur within a health facility <sup>[7]</sup>.

For this to succeed, an effective way in which to ensure that critical or high risk pregnancies could be transported to a specialised unit quickly and efficiently was needed. This led to the establishment of the very first Flying Squad program, which started with the introduction of a dedicated ambulance at each of the three main obstetric care facilities. A driver staffed each ambulance on a 24 hr basis. The remainder of the retrieval team consisted of a doctor and or a senior obstetric nurse who would accompany the ambulance to the referring facility in the event of a critical transfer <sup>[8]</sup>.

Whilst the program was well received and was met with much success, it had a few areas of concern, not least of which was the problem of the composition of the crew. Firstly, as the vehicle was to be used exclusively by the receiving unit, it often would remain dormant for prolonged periods without having received a single callout. Secondly, the low call

volume also meant that equipment was seldom checked and often poorly maintained. It also needed much commitment in terms of skilled practitioners who would avail themselves to the squad. This often meant that a busy unit would need to deploy a skilled member of staff at a time when it could ill afford to do so. This resulted in an expensive and inefficient service.

Several years after the introduction of this dedicated vehicle, the programme was re-evaluated and it was decided to incorporate it into the existing ambulance service. The term flying squad would remain but any ambulance could be dispatched to affect these transfers. The proviso was that the vehicle should be dispatched as a priority. The drawback of this new design was that as the general EMS call rate increased, the reliability with which an ambulance could be dispatched to a flying squad call declined. Over time, the general levels of satisfaction on the part of Obstetric services around the performance of the flying squad deteriorated.

This led to the establishment of the Flying Squad Workgroup; this grouping included representation from the obstetric, neonatal and pre-hospital services. This multi-disciplinary, multi-sectarian group, (including primary and tertiary services) met on a quarterly basis to discuss those aspects of the transfer service that were of concern. These included cases of poor service delivery, adverse events and near misses, as well as to discuss and introduce policy changes that would improve the levels of service delivery across the maternal and neonatal health care platform.

With the implementation of a formal METRO EMS quality assurance programme in 2005, a renewed focus on the aspects of obstetric and neonatal service was adopted. Analysis of quality assurance reports around the adverse incidents demonstrated that 56% of complaints that were received dealt with maternal and neonatal services <sup>[9]</sup>. Aspects that were of particular concern were those related to the equipment failure or inadequacy, poor

clinical management and substantial delays in response. The publication of the findings of *Hatherhill et al*, further served to illustrate some of the challenges that faced this particular component of the pre-hospital service <sup>[10]</sup>.

In 2006, the EMS management team took the decision to introduce a dedicated maternal and neonatal service to address some of the failings of the then flying squad program. The purpose of the program was to provide service excellence in the realm of maternal and paediatric pre-hospital care. The Flying Squad workgroup was then consulted on the structure, function and composition of this service to ensure that it met all the requirements of the various stakeholders. Elements of the daily operations, team composition, shift scheduling, equipment and service levels, were documented and included in the operational plan. Again, each of these aspects was consulted on to ensure ownership of the program and to help establish the framework upon which the service was offered. This process characterised the engagement model that was adopted throughout the lifespan of the program and illustrated the regular dynamic review process that was employed.

The efficient utilisation of these resources was a critical component of the operational plan. These calls were classified as 'special' according to the EMS criteria and therefore fell under the control of the provincial METRO desk. The other dispatchers would not have visibility of these resources in their list of available ambulances and the vehicles would operate on their own radio frequency.

A criterion for dispatch was developed in conjunction with the obstetrics and neonatal programs of the University of Cape Town and Stellenbosch University medical schools (*Appendices A-C*). This was to ensure the appropriate utilisation of the retrieval team. In the event that the dispatcher was uncertain as to the suitability of the request, the request was then directed to the EMS doctor for approval.

In the event that a transfer from one facility to another was needed, the referring facility would first need to discuss the case with the doctor at the accepting facility. This approval would include the utilisation of the flying squad and only once this approval was given would the squad be mobilised. In the event that the dedicated flying squad vehicle was not available, a second ambulance would be seconded from the general pool of EMS ambulances to be dispatched on the call. If an ALS transfer was needed, then an ALS crew would be seconded. Under no circumstances would a call be 'stacked' (i.e. held-over until the vehicle completed its first call).

Initially the program was structured around the provision of two ALS services that operated 24/7. This was initially based on an analysis of the 2005 data that was calculated at an average of 10.2 maternal calls and 2.7 neonatal calls per 24 hours. An analysis on the call rate and workload of the programme was performed regularly looking at the type of call, level of activity and quantity of inappropriate requests. Any alterations needed would then be referred back to the workgroup for discussion.

In 2007, the program was restructured to include one ALS resource and two ILS ambulances. This was done in an attempt to better match the demand for the resources. The ILS ambulance would transfer those Flying Squad requests where the patient was stable but needed to be transported quickly to the receiving facility. All critical cases and all neonatal transfers were transported by the ALS crew.

Staff would be allocated to the program on a six-month rotation and it was agreed with the staff that they would not be able to take any planned leave during this period to ensure maximal availability of the service. In the event of a crewmember being unavailable or ill before their intended shift, a replacement for them would first be sourced from within the team. Should this not be possible, only then would a crewmember be taken from the general EMS pool.

Shifts were based on a 12-hour cycle and handover was staggered in order to minimise disruption. In addition, crews were based at several of the receiving facilities in between calls. The purpose of these placements would be to foster greater working relationships and better understanding between the crews and the unit staff; and to provide crews with training around neonatal, paediatric and obstetric cases. In return, medical, nursing and paramedic students were placed on these vehicles as part of their practical training. In addition, crews are to attend clinical meetings and ward rounds at the units (this option was eventually stopped as the workload often meant that staff were unable to attend these sessions).

Equipment was procured for the exclusive use by the flying squad and included specialised items such as incubators, ventilators, syringe drivers and vital sign monitors. The suitability of the equipment was also discussed with the respective units and where possible attempts were made to ensure that the same make and model of equipment was procured.

While clinician satisfaction has anecdotally dramatically increased, it is not known whether the Flying Squad service has made an impact on the way this group of patients are serviced by EMS.

## **AIM**

The **aim** of this study was to evaluate whether the introduction of the dedicated obstetric and neonatal Flying Squad transfer programme resulted in greater efficiency and improved response times within the Cape Town Metropolitan area.

## LITERATURE REVIEW

### Intensive Care Facilities

The provision of intensive care facilities have remained a challenge for many governments tasked with the responsibility of providing a health service to its population. The principles of health economics and the logistics that accompany this provision have led to the inevitable centralisation of intensive care services <sup>[12]</sup>. This has resulted in significant challenges for many of the developed nations with regards to inter-facility transfers, with overwhelming evidence demonstrating a centralised system of patient transfer to be the most safe and most effective<sup>[13, 14, 15]</sup>.

Within the South African context, this challenge assumes greater proportions. The larger land mass, greater distances, together with its poor transport infrastructure and limited resources, have placed a considerable strain on the country's pre-hospital services. *Scribante and Bhagwangee* demonstrated this in their audit of critical care resources in South Africa <sup>[16]</sup>. Their objective was to establish the efficacy of critical care transfers in hospitals both with, and without ICU/HCU facilities: they reported that any significant delay in transfer negatively influenced the morbidity, mortality, length of stay and ultimately efficient resource utilisation. Their findings demonstrated several deficiencies in the transfer of critically ill patients, with time to collect greater than an hour in all but two of the provinces. They argued that not only was there very limited data to address the efficacy of these transfers, but also that transfer procedures were neither centralised nor standardised. They therefore recommended that professional authorities and the relevant government departments should establish guidelines and standards for these. This study had several limitations however, not least of which is the fact that the data on 'time to

*collect'* relied on the subjective views of the hospital or unit managers, with no objective data obtained from the pre-hospital providers. It therefore suggests the need for appropriate prospective data collection; it does however demonstrate sufficient evidence to argue for integration and regionalisation of critical care transfers.

## **Obstetric Emergency Care**

Unlike the centralisation of intensive care services, obstetric care has very much been decentralised as part of the emergence of primary health care and the commitment to ensuring greater access to essential health services<sup>[17]</sup>. However, the result of the different strategies between intensive care and obstetric care has been the same; the realisation of the critical role 'referral systems' assume within health. The quality of obstetric emergency care has therefore been the central focus of governmental health programs and initiatives. Key maternal health measures such as the Maternal Mortality Rate (MMR) and the Infant Mortality Rate (IMR), have long been accepted as valuable indicators of the success of a particular health system in meeting the healthcare needs of its population<sup>[7]</sup>.

In light of this, *Murray and Pearson* have suggested that the success of maternal (and neonatal) referral systems can be considered a useful 'tracer' for analysis of healthcare systems<sup>[17]</sup>. The authors identified the key requisites for successful maternity referral systems to include:

- a referral system that is informed by the specific needs and healthcare capabilities
- an adequately resourced referral centre and formalised transport arrangements
- greater collaboration and consultation around local protocols
- policy support.

## Obstetric Referral Systems in Developing Nations

This notion of a formalised maternity referral system has its origins in the strategy of risk management and screening in the antenatal period with the goal of early referral to more specialised services <sup>[17]</sup>. However, this brings with it significant challenges even in developed nations. *Dudenhausen et al* examined the appropriateness of the ‘hospital of delivery’ by comparing information obtained from ‘maternity logbooks’ with published guidelines on antenatal transport and perinatal care facilities in German hospitals. He concluded that if a formalised maternity referral system is to be successful, it must be accompanied by adequate education around antenatal risk factors, and include the counselling of women on their place of delivery <sup>[18]</sup>. This principle is as relevant in developed countries as it is in the more developed nations.

In a review published by the *National Committee on Confidential Enquiries into Maternal Deaths* (NCCEMD), the top five causes of maternal death in South Africa were: complications of hypertensive conditions in pregnancy, AIDS, obstetric haemorrhage, pregnancy related sepsis and pre-existing medical conditions <sup>[19]</sup>. Obstetric haemorrhage and AIDS were identified as the most common cause at level 1 and level 2 hospitals respectively. The review also identified non-attendance and delayed attendance as the most common patient-orientated problems whilst poor transport facilities and a lack of intensive care facilities were the major administrative problems. This serves to highlight the magnitude of the challenge faced by developing nations. Whilst there is evidence that great gains are to be made by ensuring that women with pregnancy complications are able to access specialised obstetric care quickly, and that the introduction of a formalised referral system will greatly facilitate the efficiency with which this is achieved, there are still significant barriers facing developing nations <sup>[17, 20, 21]</sup>.

Access to 'care for delivery' in developing countries, is hampered by the poor communication and transport services; the unscheduled nature of birth; the role and responsibilities of women within the communities; and the fear of travelling unaccompanied at night <sup>[22]</sup>. If these challenges are to be overcome, home grown solutions and initiatives, based on an assessment of local capabilities and priorities are key <sup>[17, 20, 23]</sup>.

In an uncontrolled before and after study, *Fournier et al* examined the effect of a national referral system on the quality of emergency obstetric care in Mali <sup>[24]</sup>. The study demonstrated that following the introduction of the referral system, the relative risk of maternal death was half the risk recorded before the intervention. The authors concluded that national programmes can be implemented in developing nations without major external funding and that significant gains are to be made upon their introduction.

This argument was supported by several studies examining obstetric referral systems in developing countries <sup>[22, 26, 27]</sup>. Initial approaches to these challenges have evolved into recommendations that support the development of community based solutions. *Chiwuzie et al* explored one such initiative which aimed to help establish community-managed loan and transport systems for women with obstetric emergencies <sup>[25]</sup>. *Shehu et al* also evaluated a similar transport initiative in Nigeria. Communities were mobilised to approach private transport owners to help establish an affordable emergency transport option for women with obstetric emergencies <sup>[20]</sup>. This initiative also enjoyed some success. They concluded that such initiatives could easily be sustained in low-income communities but that it would require continued effort and engagement with the communities.

Therefore, the challenge in developing countries is that whilst the broad principles as applied to maternity referral systems and transport solutions appear to be universal, the solutions, if they are to be sustainable, must be community based and be informed by local priorities and capabilities <sup>[17]</sup>. There appears to be a significant disparity between the policy

documents and universal principles; and the reality that many women face in the developing world in attempting to access maternity emergency care services.

## **Neonatal Emergency Care**

Much of the literature around the subject of neonatal transfers published in recent years has also largely focused on the architecture and composition of a neonatal and/or paediatric transfer service <sup>[31, 32]</sup>. Since the earliest published work of Trent-Victoria, consensus appears to have grown around the need to centralise maternal, neonatal and paediatric intensive care <sup>[10, 34]</sup>. *Ramaryan et al* suggested that this regionalisation of inter-hospital transfer teams is the logical consequence of this centralisation of health resources <sup>[35]</sup>.

In 2006, the French ministry registered its commitment to this centralisation initiative by having it written into law <sup>[36]</sup>. They issued a legal text relating to the organisation of maternal transports stating that by the end of 2008, all transfers of women and neonates will be restructured into a centralised model. *Clerc et al* examined the impact of this process through their postal survey conducted 15 months after the establishment of a regional hotline centre.

They targeted 146 neonatologists and obstetricians with questions relating to the quality of communication and general transfer organisation following the restructuring process. The result found that 85.3% of the respondents felt that the regional centre had significantly improved efficiency and 96% felt that the model should continue.

## A Continuum of Care

The link between obstetric emergency care transfers and neonatal services has been explored by several researchers<sup>[37, 38]</sup>. *Hauspy et al* compared neonatal outcome after intra-uterine obstetric transfer with neonatal outcome following postnatal neonatal transfers. The authors illustrated a link between complications in pregnancy were associated with a higher incidence of neonatal complications. They demonstrated that preterm rupture of membranes, pre-eclampsia and pre-term labour were more frequent in the intra-uterine transfer group; and that this group had a lower birth weight and gestational age<sup>[37]</sup>.

*Menthonnex* also set out to analyse the trend of increasing neonatal transfers and commented that this was linked to the increase in the number of intra-uterine transfers because of threatened premature delivery. He added that the introduction of better obstetric transfer and referral systems as well as the development of well-designed protocols would substantially limit the risk of neonatal complications<sup>[38]</sup>.

Shlossman et al, who analysed neonatal transfers to one tertiary centre over a period of 3 years, shared this view. The study found that the incidence of respiratory distress syndrome, intraventricular haemorrhage, broncho-pulmonary dysplasia and mortality; were all significantly increased in the neonatal transfer group<sup>[21]</sup>. The authors concluded that advances in neonatal care and techniques have not improved on the significant advantage of decreased mortality and shortened hospital stay that result from early obstetric (in-utero) transfers.

## Neonatal Transfers

The solution that has been proposed to meet the challenge of centralisation is the establishment of a specialised retrieval team. In support of this argument, evidence has been presented that revolves around the unacceptably high rate of adverse events associated with these transfers <sup>[10, 41-43, 47, 48]</sup>. One such study demonstrated very early on the unacceptably high occurrence of adverse events <sup>[42]</sup>. *Ralston and Barry* showed that adverse events occurred in 75 % (42) of the neonatal inter-hospital transfers studied with 23% (13) of these events considered to be life threatening. Ninety-five adverse events were reported in total with inadequate respiratory support, hypothermia and drug errors among the most common. The authors concluded that the high incidence of significant adverse clinical events were because of the inexperienced clinical escorts using inadequate or malfunctioning equipment. They concluded that it would be appropriate for the transfers to be performed by fully trained personnel and were among the first to call for the establishment of such specialised teams.

*Usaro et al* examined the safety of long distance transfers of critically ill neonatal patients after the establishment of a specialist retrieval team <sup>[43]</sup>. In their retrospective analysis of 66 critically ill transfers, they recorded no major complications despite the fact that 79% had ARDS, all had hypoxia and 89% required cardiovascular support. They concluded that with a dedicated transport team and proper stabilisation prior to transfer, ground transportation of critically ill patients over long distances, could be performed safely.

*Wallen et al* suggested that many of these events seem to be because of the transfer process itself and set out to prove this by evaluating the transport of patients within a health facility <sup>[40]</sup>. They conducted <sup>[40]</sup> a prospective study into the transport of critically ill

paediatric patients within a 250-bed university children's hospital with a 50-bed intensive care unit.

It demonstrated a significant change in at least one physiologic variable in 71.7% of transports and at least one equipment-related mishap in 10% of transfers. In 13.9% of the transfers, at least one intervention was needed because of a physiological change or equipment error. They concluded that the risk of an adverse event and the requirement of a major intervention appear to be related to the severity of the illness as well as the duration of transport. They added that critically ill children could experience serious adverse events simply through the process of a transfer within the hospital; and that the risk of any diagnostic study should be weighed against the risk of an anticipated adverse event.

### **Specialist Retrieval Teams**

The advantage of executing these transfers safely whilst providing nearly the same level of care as that received at the ICU/NICU has resulted in the acceptance of the specialist retrieval team as routine practice <sup>[49, 50, 51, 52]</sup>. In addition, the creation of a dedicated specialist retrieval team has several tempting advantages, the first of which is that it would facilitate greater efficiency (in that resources are earmarked for specific functions and would not need to perform these transfers over and above their existing workload) - this would ensure round the clock availability. Secondly, retrieval teams by their nature provide a specialised skill set that is easier to maintain and audit. Quality management of such a specialised program is easier to oversee and administer as is the training that would be required to ensure that staff maintain a high degree of skill currency. Thirdly, the establishment of a specialised retrieval team provides fit-for-purpose vehicles and equipment. This ensures greater use of integral vehicle equipment with compatibility of

incubators with ambulances. The result is reduced trolley weight with greater safety for staff and patients <sup>[14]</sup>.

While majority consensus would indicate that the establishment of a specialist retrieval team appears to provide the best solution for the critically ill maternal or neonatal transfer, several researchers have cautioned against the acceptance of this notion <sup>[44, 46]</sup>. *White et al* examined the morbidity and mortality associated with a specialist paediatric transfer team, but could not demonstrate a statistically significant reduction in the mortality rate <sup>[47]</sup>. They conducted a prospective, observational study on 284 critically ill paediatric transfers from a district general hospital to a tertiary paediatric intensive care unit. The study occurred between the periods before and after the implementation of a dedicated paediatric intensive care transfer service. Their findings demonstrated an overall decrease in the standardised mortality between the 2 periods but this was not only limited to the transfer process. A reduction in mortality was also found in non-transferred ICU patients in the same area leading the authors to conclude that this more than likely reflected improved performance of the units themselves. They suggested that mortality in critically ill paediatric patients were more dependent on the performance of the intensive care unit to which the patient was referred than on factors that occur during transfer. The limitations of this study was that the study sample was small (284) and used standardised mortality as the only indicator.

Several authors have argued that this model also has distinct disadvantages in that they are costly to maintain, and require significant coordination and investment with respect to logistics. These may cause several challenges concerning response time and resource availability <sup>[14, 44, 45, 49]</sup>. The question on the suitability of such a model in an already strained, under-funded and poorly resourced pre-hospital service of a developing country is certainly valid.

A further disadvantage that is suggested when debating the merits of a retrieval team has been the concern that the use of a specialised retrieval service would lead to unfamiliarity with vital resuscitation and stabilisation skills of health facility staff at the referring hospitals [32].

*Ramnarayan et al* compared the proportion of vital stabilisation skills performed by referring hospital staff in two distinct time periods before and after the establishment of a retrieval service. They demonstrated that a greater proportion of the referring hospital staff was performing vital stabilisation skills prior to the arrival of the retrieval teams, than was present before the establishment of the specialist team. The authors concluded that the provision of this service had not resulted in a loss of vital skills but commented that the quality of these interventions was not evaluated. They added that increased practise of stabilisation skills does not equate to greater proficiency in the skill set in question. A further limitation of the study is that it does not account for any training initiatives that may have been implemented.

Cost considerations must also enter into the establishment of a specialist retrieval team. One author suggested that these would be explicit rather than hidden; and that there should be no reason why such a specialist team should be more expensive than existing arrangements [14]. With the prospect of significant savings to be made in the procurement and maintenance of dedicated equipment, and the secondment of staff for fixed periods, a case can be made for this cost effective solution.

## **Research Challenges**

Several authors have cited the challenge of establishing a randomised controlled or interventional study design in this particular cohort of patients [14]. They commented on the

difficulties associated with the interpretation of studies focusing on neonatal transfers and specialist retrieval teams <sup>[53]</sup>. Further problems associated with the absence of objective measures, poorly defined indicators and vague definitions of measurable outcomes makes the evaluation and comparison of findings difficult. Whilst indicators have been identified for the evaluation of the quality of Intensive care, consensus on robust indicators for the assessment of critically ill neonatal transfers appears to be lacking.

This difficulty can be seen in a systematic review that examined the association of the duration of transfer with neonatal mortality <sup>[54]</sup>. *Mori et al* based their review on that in the neonatal Cochrane Collaboration conducting their search across six major databases including Medline and EMBASE. Their initial yield of 462 trials was eventually reduced after screening by title and whole articles to 1 trial conducted in India. Whilst the cross-sectional study demonstrated a 79% higher odds of death in neonates with long duration of transfer after adjusting for the confounding factors effects of admission weight, hypothermia, hypoglycaemia cyanosis and prematurity.

However, the modes of transport used in the study were not clearly defined and included patients travelling by foot, taxi rickshaw and ambulance. The authors concluded that whilst there appeared to be a positive association between transit times and mortality during admission, exposure status, outcome status and other co-variables were poorly defined, suggesting a high probability of bias.

Still, only one study could be found which set out to examine whether a dedicated neonatal transfer service could result in greater efficiency <sup>[55]</sup>. However, this study failed to define the indicators it measured and results were vague and difficult to interpret. Whilst it claimed to show that the dedicated service it examined displayed a reduction in efficiency, how the authors came to this conclusion is not clear.

## Indicators, Measures and Outcomes

The merits of a specialist retrieval team rely on the model's ability to meet the requirements of providing quality care on a cost effective basis. *Ramnarayan* suggested that performance indicators generally involve the assessment of patient outcomes (mortality, adverse events etc.) and process measures (transit times, mission times etc.)<sup>[53]</sup>.

In reviewing the literature, the majority of the studies appear to have utilised mortality as a measure of the performance of retrieval teams. *Ramnarayan* has also questioned the use of patient mortality as a marker of retrieval performance adding that death during transit is a very rare event. He suggested that transport related mortality, when used as an indicator, might be more appropriately measured from the point of mobilisation to the time of ICU discharge.

'Prediction-of-mortality' scores do exist, and have been widely used as a measure of performance in Intensive Care Units<sup>[57]</sup>. Examples include the Paediatric Index of Mortality (PIM), the pre-intensive care unit Paediatric Risk of Mortality (PRISM) and the Clinical Risk Index for Babies (CRIB). These prediction scores have been applied to Paediatric and Neonatal retrieval team performance, but present several challenges. The first of these is that none of the scores has been developed specifically for the assessment of the transfer process. As such they often contain measures that are specifically focused at the hospital care and are not readily available at the point of referral. Secondly, this system often relies on data obtained after the retrieval team has arrived at the referring hospital and thus ignores a critical aspect of the transfer process – the point at which the transfer request was made. Any evaluation of the retrieval process must include in its assessment the information obtained by the control centre. This would provide an objective measure of

disease severity and prognosis and could facilitate more accurate triage and resource allocation.

*Broughton et al* proposed a Mortality Index for Neonatal Transportation (MINT) score that is based on the information given at the first telephone contact of a retrieval service <sup>[57]</sup>. This is an integer-based score developed through a multivariate logistic regression analysis of data obtained from the New South Wales Newborn and Paediatric Emergency Transport Service database. The MINT score was based on several variables and included: pH, age, Apgar at 1 min, Birth Weight, PaO<sup>2</sup>, the presence of congenital abnormality and whether or not the patient was intubated at the time of the initial call. The authors concluded that the MINT score was validated and exhibited performance similar to that of the Transport Risk Index of Physiologic Stability (TRIPS) but that it had the added advantage of using objective data; and that it could be completed on information obtained at the time of the transfer request.

The absence of a widely accepted transport score that adjusts for differences in patient severity has contributed to the difficulty encountered in trying to compare patient outcomes between different studies. There has been a strong call on the part of several authors for far more objective studies aimed at developing a universally accepted pre-transport illness severity score that would enable valid comparison of patient outcome.

'Process' measures offer an alternative assessment of retrieval team performance than patient outcome. Examples of such measures include transit, mission and stabilisation times. The challenge of establishing universally accepted benchmarks in this regard lies in how to identify the key indicators as well as defining the terminology that is to be used <sup>[53]</sup>. Often terms relating to 'time' are used synonymously and in an overlapping fashion. This has made the task of comparing findings and times across different studies difficult.

Several studies have however examined the association between duration of transport and morbidity. Their findings appear to indicate that the time taken and the distance of transfer impacts significantly on patient outcome <sup>[39, 53, 54]</sup>. *Mori et al* examined this association in a historical cohort study of 4966 neonatal transfers born between 1980 and 2000. Duration of transport was used as the exposure and neonatal death as the outcome. Transit time was defined as the time in minutes between departures from the referring hospital until arrival at the receiving facility.

The findings demonstrated that those transported with a long duration of transport had a 12- 30% higher hazard of neonatal death than those with a shorter duration. For transfers greater than 90 min, they concluded that they had more than twice the hazard even after taking into account confounding factors such as severity of illness, gestational age and birth weight.

*Abdel-Latif and Berry* measured transit times of both immediate and emergency retrievals, and compared these in neonatal and paediatric patients <sup>[56]</sup>. Compared with paediatric retrievals, neonatal transfers had significantly longer, stabilisation and handover times, and therefore also demonstrated longer overall mission times. The authors concluded that minimising the time from the first contact with the health service until the patient's arrival at definitive care should be regarded as the prime focus of any retrieval service. They cautioned however that a balance must be sought between the notion of stay and play and the principles of scoop and run, as the simply striving to effect the quickest patient retrieval may have disastrous consequences.

Response times have also been identified as a valid measure of performance. *Greisen and Hopkins* have both commented that response times are an important measure of quality and may affect subsequent patient outcome <sup>[12, 15]</sup>. Response times in turn are impacted

upon by many factors including clinical urgency, resource structure (dedicated resource vs. next available) geographic and functional distances <sup>[13, 16, 17]</sup>.

The limitations of these and other studies that have explored the use of 'response time' as an indicator, are contained in the fact that the definition of 'response time' is not universally understood. Within the Western Cape EMS, response time is defined as the time in minutes from the receipt of the initial call until the arrival of the team at the referring facility.

In contrast, *Caverni et al* used 'response times' to refer to the time that has elapsed from the initial call for transport until the retrieval team departs for the receiving hospital <sup>[55]</sup>. *Abdel-Latif and Berry* and *Ramnarayan* both used 'response time' to include the time spent in discussing and allocating a receiving unit <sup>[53, 56]</sup>. These varied definitions render the comparison of findings impractical and consequently make the determination of universally accepted benchmarks and standards of care all the more difficult.

### **Neonatal Referrals in South Africa**

Locally, the limited availability of data on critically ill patient transfers renders any attempt to determine efficiency or establish standards, near impossible <sup>[16, 44]</sup>. *Hatherhill et al* called into question the Western Cape EMS's capacity to safely transfer critically ill neonatal and paediatric patients in their audit of paediatric intensive care unit transfer activity <sup>[10]</sup>. Their evaluation of the 'non-specialised' transport of 202 children transferred to their PICU demonstrated a high incidence of adverse events. Paramedics performed most transfers (82%) with 76% of the transfers executed via ground transport. Findings show a 36% technical adverse incident rate and a 9% critical incident rate in patients transported by ambulance. In contrast, retrievals performed by intensive care staff (10%) had a lower

incidence of technical adverse events. These included misplaced or mal-positioned endotracheal tube; loss, blockage or dislodgement of venous access; and failure or absence of monitoring devices. However, there was no difference in the incidence of clinical or critical adverse events between the transfers performed by paramedic and intensive care staff.

Whilst this may demonstrate the clear advantage of a specialist retrieval team, all of the transfers done by the intensive care staff were performed via a fixed wing aircraft. This would significantly influence the findings as the environment and available resources are substantially different from those present in road transfers. In addition, the adverse technical events were not of equal consequence with events ranging from life threatening (missed oesophageal intubation) to potentially unimportant (failure to obtain venous access) <sup>[44]</sup>. Combining events with such diverse outcomes, together with the different environments mentioned earlier, makes the process of reaching firm conclusions difficult.

Amidst these considerations, *Duke* has suggested that the case for a specialist retrieval team in South Africa is more complex <sup>[41]</sup>. The absence of reliable public transport to most primary health facilities as well as the lack of access by paediatric (and obstetric) patients to appropriate health care, stands in stark contrast to the establishment of a specialist retrieval team. This fact together with a struggling and poorly resourced health system may do little to impact on the overall fall in regional and national child mortality. However, even within the context of a developing country, with limited resources and competing health care priorities, the authors present a strong case for the establishment of a specialist retrieval team. Whilst they do suggest that further prospective studies based on objective data are needed, they recommend that the establishment of a specialist retrieval team and focused advanced life support training might reduce the incidence of technical adverse

events. They added that it would be reasonable to expect a parallel reduction in the incidence of cardio-respiratory adverse events.

## STUDY DESIGN AND METHODS

This study was undertaken in the Cape Town metropolitan area.

### **Purpose of the Study**

The aim of this study is to determine whether the establishment of a dedicated obstetric and neonatal flying squad resulted in improved performance within the setting of a major metropolitan area. For the purposes of this study, improvement was defined as having completed incidents in terms of what *Ramarayan et al* referred to as process measures, i.e. a measure of the time expended during the execution of the call. Particular focus was spent on what are regarded by METRO EMS as the most important indicators: dispatch, response and mission times.

### **Methodology**

I undertook a retrospective review of all obstetric and neonatal Flying Squad records during the two separate 1-year periods 1 January - 31 December 2005 and 1 January – 31 December 2008.

### **Inclusion and Exclusion Criteria**

All data captured by METRO EMS during the study period were eligible for inclusion. There were no exclusions.

### **Data Collection**

Data are collected at the METRO EMS Cape Town Control Centre for every call received and processed in Cape Town. Data for this study were collected from the Computer Aided

Dispatch programme as used by the Control Centre (all call data are routinely imported from the GEMC<sup>3</sup>® programme into a central data warehouse administrated by the CAD vendor).

## **Data Analysis**

*Response times, transit times and mission times* for all maternal and neonatal transfers were examined in an effort to establish the squad's performance. A comparison was made between the performance achieved by METRO EMS prior to the introduction of the programme and the performance achieved after the commencement of the programme.

A further comparison was made with the performance of EMS on all other P1 calls. This was done in an effort to establish whether or not any improvement demonstrated was statistically significant and not merely a reflection of the general improvement achieved within METRO EMS.

Data were extracted into a password protected Microsoft Excel (® Microsoft, Richmond, Va) database. Using Excel tools, pivot tables were created in order to run four distinct search queries.

- Query one was created by searching for all incidents completed by the Metropolitan service for the 2005 Calendar year. Incidents retrieved in this manner were then filtered by case type, selecting those incidents categorised as 'local incubator' and 'maternity flying squad', and finally filtered for P1 incidents.
- Query two was created by searching for all incidents completed by the Metropolitan service for the 2008 calendar year. This time incidents were filtered for the new case types that had been created, namely: 'MATERNITY FLYING SQUAD' 'NEONATAL FLYING SQUAD' and 'PAEDIATRIC FLYING SQUAD'. The older case types were added to ensure that those incidents were included that may have been

captured according to the old nomenclature. By filtering for incidents prioritised as P1, the sample remained valid as all P1 incidents would have been assigned to the new flying squad vehicles.

- Query three was generated by searching for all incidents completed by the Metropolitan service for the 2005 calendar year; results were then filtered to exclude those case types used in Query one, and filtered for P1 incidents.

- Query four was generated by searching for all incidents completed by the Metropolitan service for the 2008 calendar year; results were then filtered to exclude those case types used in Query one, and filtered for P1 incidents.

The result was the creation of two distinct data samples that would form the basis for the rest of the study, one for 2005 and the other for 2008. Each sample in turn contained four separate data sets: Neonatal flying squad, Obstetric flying squad, Inter-facility transfers and All Calls.

### **Measured Outcomes**

Each of the data sets was then subjected to a set of different filters in order to examine the performance related measures of each incident type. These were then examined under the following categories:

Dispatch: 'Time to dispatch' is defined as the time in minutes from the receipt of the telephone call until an ambulance has been assigned to the incident.

This was examined and expressed as a percentage of the total responses. Percentage dispatches under 4 minutes and under 10 minutes were analysed for each of the data subsets.

Response: 'Response time' is defined as the time in minutes from receipt of call until the vehicle arrives on scene <sup>[\*]</sup>. Response time was analysed for each of the subsets with specific reference to incidents responded to in under 15, 30, 40 and 60 minutes. These subsets were based on a pre-defined time frame determined by the service. In addition, trend graphs were created for each of the subsets in order to analyse performance improvement over time.

Average status times: This is calculated using the time in minutes for each of the individual observations and then calculating the mean. This was reported for each of the different status modes namely: '*Time to dispatch*', time '*to scene*', '*response time*', '*on-scene*' time and '*to hospital*' time. No value could be determined for the time spent at the hospital due to missing data.

Workload trends: This was analysed by filtering the data sets for the time the incident was captured and then expressed as hours in the day and days in the week for both sample periods.

Completion codes: Completion code refers to a record of an outcome or resolution of the individual incident. Each incident can only be assigned one completion code in GEMC3. Each of the data sets was examined for their individual completion code and these were then analysed according to their frequency.

Incident location: GEMC3 captures each incident location and maps it to a specific territorial code. This code is then located on a map through processing it through a GIS programme. A series of maps were created to represent both incident count and average response times for the neonatal and obstetric data sets.

### **Statistical analysis**

Data were imported from the CAD using Sequel server<sup>®</sup>. Mean, median, range, standard deviation and 95% confidence intervals were used to describe different data sets. A p-value  $\leq$  0.05 was regarded as statistically significant; chi square test was used to compare categorical data.

A MIXED MODELS analysis was employed using SAS<sup>®</sup> Systems. A repeated-measures ANOVA was used, where the year was regarded as the repeated measure and the factor was the variable.

Data analysis and simulations were performed using pivot tables created in Microsoft Excel<sup>®</sup>. Charts were generated from both Excel<sup>®</sup> and SAS<sup>®</sup> Systems. GIS maps were generated using ARC Map<sup>®</sup>, v9.2

### **Ethical considerations**

Ethics approval was granted by the University of Cape Town Faculty of Health Sciences Ethics Committee (*REC REF: \_\_\_\_\_*)

Data were stored on a password protected work computer. No patient details were extracted from the METRO EMS system.

## RESULTS

### Dispatch

The total number of neonatal and maternal P1 incidents dispatched by the Metropolitan Emergency Control Centre (ECC) for 2005 was 3,257, with the highest call volume recorded in December. For the same period, the ECC dispatched 46,074 other P1 (*All other P1*) calls, with the highest volume recorded in July. In 2005, the maternal and neonatal calls therefore constituted 6.6% of the total P1 incidents

During 2008, the total number of Flying Squad incidents dispatched was 4,865 (with July reflecting the highest call volume). This is an increase of 1,608 maternity and neonatal P1 incidents compared with 2005 (49.3% increase). In 2008, 'All other P1' calls also reflected a substantial increase from the 2005 dispatch count: 65,885 calls were dispatched reflecting an increase of 19,811 (43% increase in call volume) (Table 1).

Incident Case Type	2005 Response Count	2008 Response Count	2005-2008 increase
P1 Neonatal incidents	329	867	63.5%
P1 Maternity incidents	2,928	3,998	36.5%
All Other P1 incidents	46,074	65,885	43%

**Table 1:** Response Count per Incident Type - 2005 vs. 2008

Dispatch performance was measured as a ratio of all incidents that were dispatched within 4 minutes. The percentage for the maternal and neonatal group in 2005 was recorded as 11.7%: this improved to 31.9% when the threshold was extended to 10 minutes. This performance is still below that recorded for 'all other P1' calls dispatched in both the 'under 4 minutes' and 'under 10 minutes' categories (see figure 1).

Percentage of Flying Squad incidents dispatched within 4 minutes increased to 46.6% ( $p < 0.0001$ ) by 2008. This performance increased to 79.3% ( $p < 0.001$ ) when the 10 minute threshold was used. In contrast to the performance in 2005, this response percentage was greater than that achieved for the dispatch of 'all other P1' calls in both the 4-minute ( $p < 0.0001$ ) and 10-minute categories ( $p < 0.0001$ ) (figure 1).

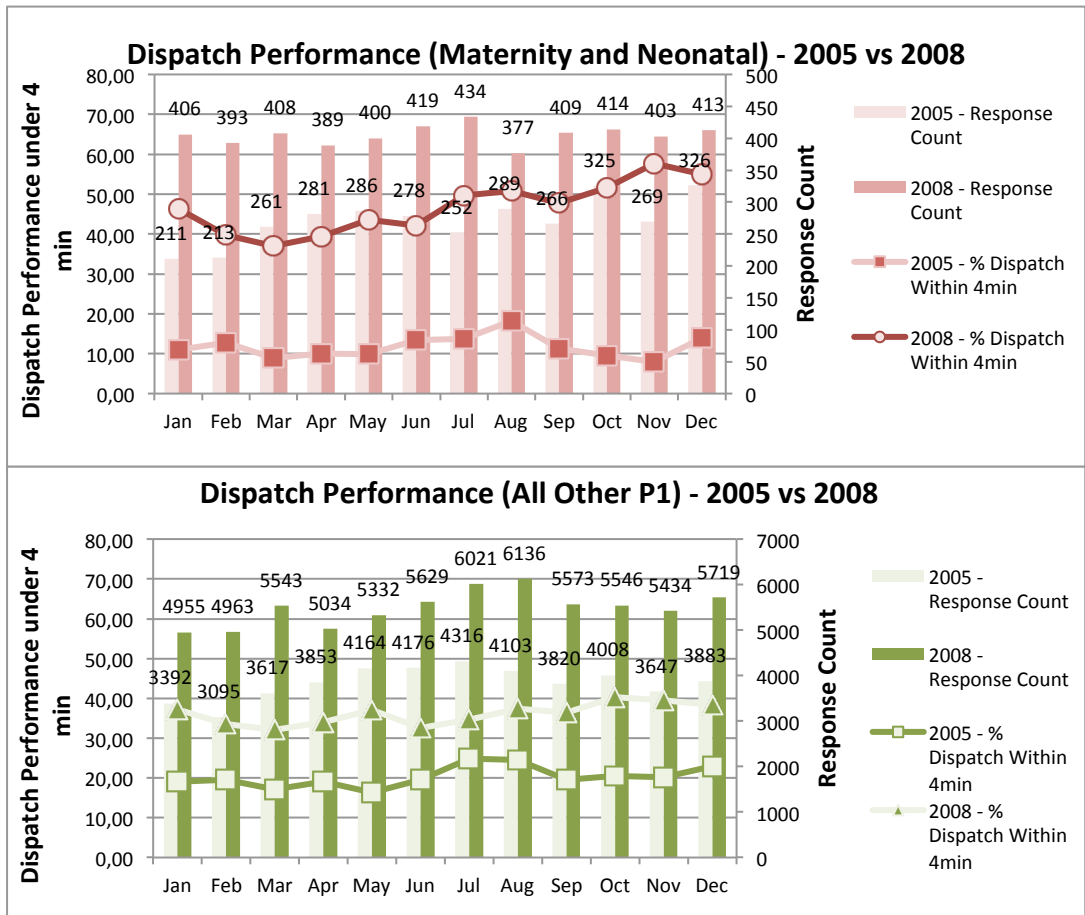


Figure 1(a) and (b): Dispatch Performance for Maternity/Neonatal (1a) and Other P1 (1b) - 2005 vs 2008

A Means plot of this improvement in dispatch performance illustrates an interaction in improvement over time with Obstetric and Neonatal incidents showing the greatest improvement in performance ( $p < 0.0001$ ) (Figure 2) .

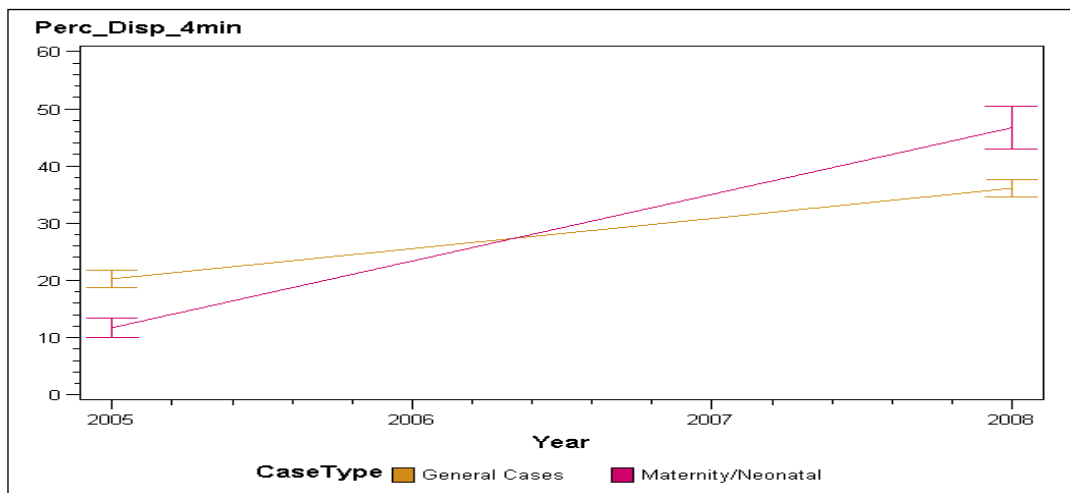


Figure 2: Means Plot of percentage dispatched within 4 min by Case Type per year

### Sub-group Analysis

Data for the Flying Squad category of incidents also reveals that Neonatal incidents for 2005 constitute 11.2% of all Flying Squad incidents, whilst in 2008 this increased slightly to 13.9%. The newly created 'Paediatric Flying Squad' incidents only accounted for 4.0% of all Flying Squad incidents in 2008.

Despite constituting a larger percentage of the Flying Squad category, the greatest improvement in dispatch performance was observed in the maternity incidents (mean 54.0% and 84.7% of incidents dispatched within 4 and 10 minutes respectively). Figure 3 illustrates the improvement in the 4-minute dispatch performance time in relation to that achieved in the Neonatal and 'All Other P1' incidents (the secondary axis represents response count per incident type).

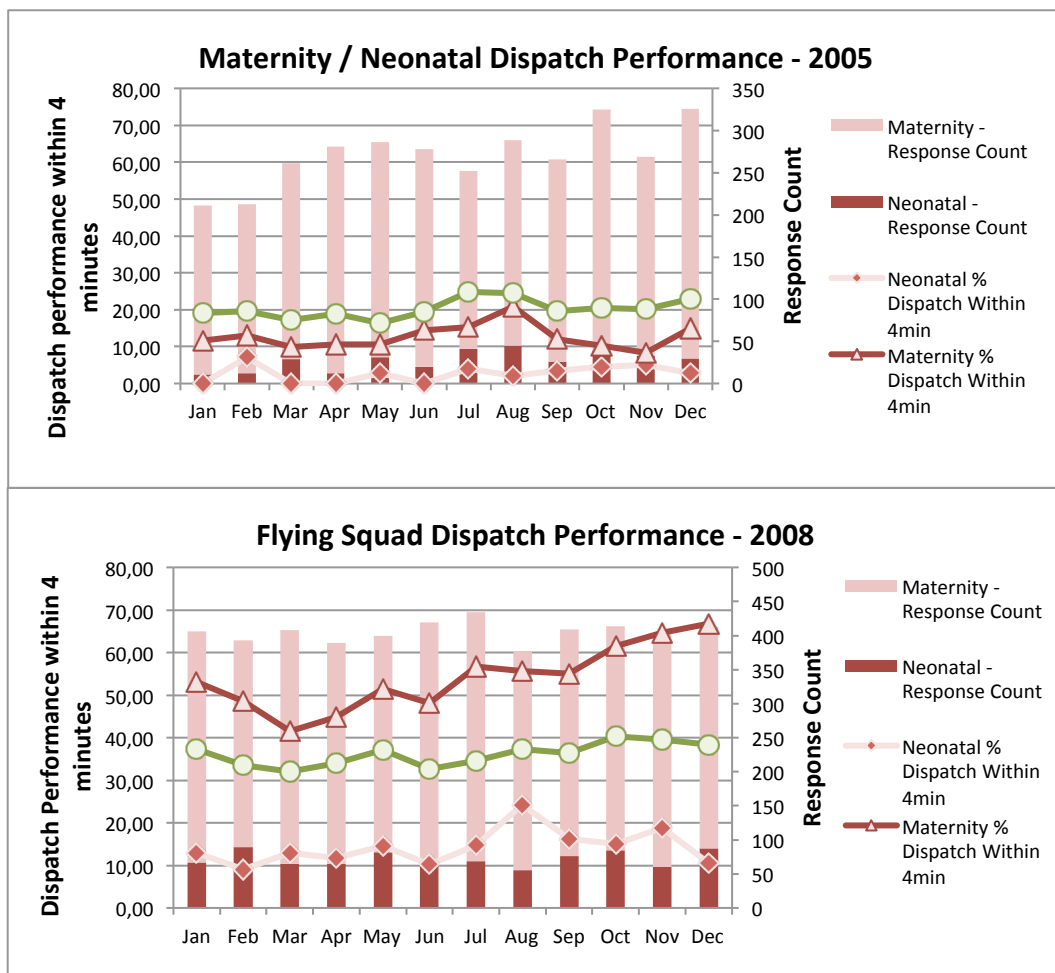
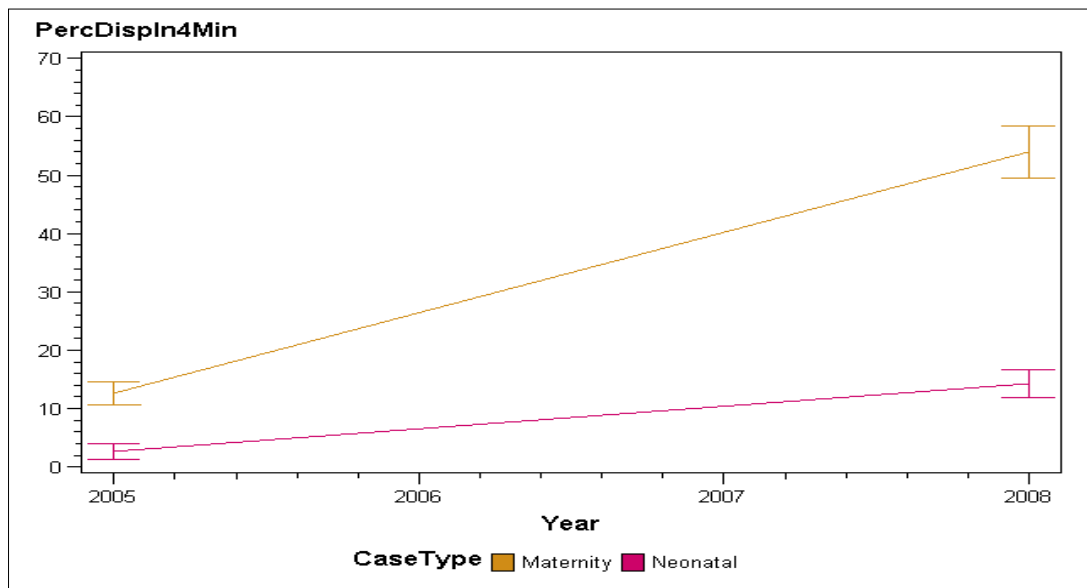


Figure 3 (a) and (b): Dispatch Performance within 4 min - Maternity/Neonatal vs. Flying Squad

A means plot of this improvement demonstrates no interaction (indicated by the parallel lines) between the improvement observed in both the Neonatal and Maternity dispatch (figure 4). Whilst both achieved a significant improvement ( $p < 0.0001$ ), maternity dispatch demonstrated the most improvement between 2005 and 2008 ( $p < 0.0001$ ). In contrast to its performance in 2005, the dispatches of maternity cases achieved a better performance than that recorded for 'all other P1' incidents. Of the three incidents, Neonatal dispatches still had the worst performance result.



**Figure 4:** Means Plot for percentage dispatched within 4 min by case type per year

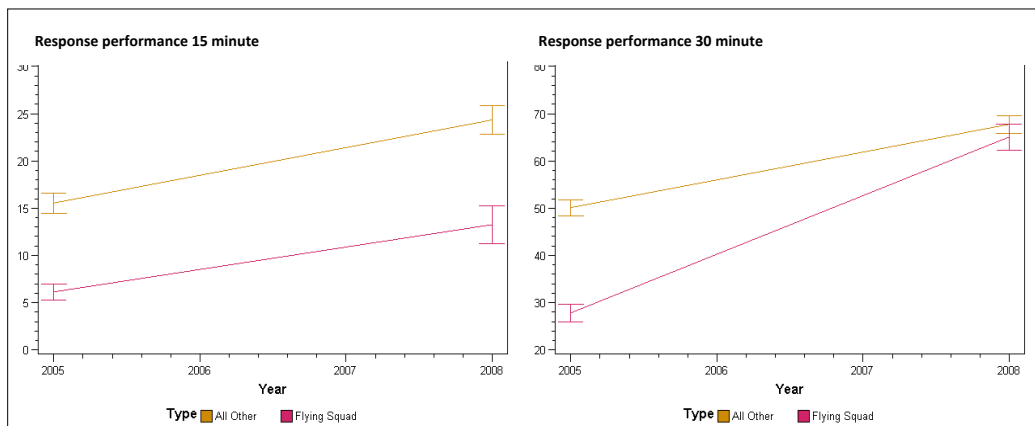
## Response

'Percentage of incidents responded to' was analysed at 15, 30, 40 and 60 minutes. Table 2 indicates the performance of Maternity/Neonate responses in relation to that achieved for 'All other P1' incidents for 2005 and 2008. Whilst there was a substantial improvement in the response performance achieved by the Flying Squad ( $p < 0.0001$ ), the performance is still below that achieved by the 'All other P1' category.

		RESPONSE COUNT	% RESPONSE WITHIN 15	% RESPONSE WITHIN 30	% RESPONSE WITHIN 40	% RESPONSE WITHIN 60
2005	Maternity / Neonate	3257	6.1	27.8	42.8	63.2
	All Other P1	46074	15.5	50.0	64.6	80.9
2008	Flying Squad	4865	13.2	65.1	79.0	91.6
	All Other P1	65885	24.4	67.8	80.7	92.3

**Table 2:** Response Time Performance at 15, 30, 40, and 60-minute intervals by Case Type per year

Improvement in performance was observed in both 'All Other P1' and 'Flying Squad' incidents at the 15-minute threshold. Whilst this improvement was statistically significant in both instances ( $p < 0.0001$ ), this improvement was small. When examining the performance improvement at the 30-minute mark, a substantial improvement is observed in the Flying Squad category between 2005 and 2008. This improvement is greater than that achieved by the 'All Other P1' category and is also statistically significant ( $p < 0.0001$ ) (Figure 5).



**Figure 5:** Means Plot analysis of Response time performance for 15minute and 30 minute by case type per year

### Sub Group Analysis

In 2005, the response performance for P1 Maternity incidents was 6.6%. The P1 Neonatal performance was even poorer with only 1.8% of all P1 Neonatal incidents responded to within 15 minutes. All of these were substantially below the performance recorded for 'All other' P1 incidents which was reflected as 15.2% of these calls responded to within 15 minutes.

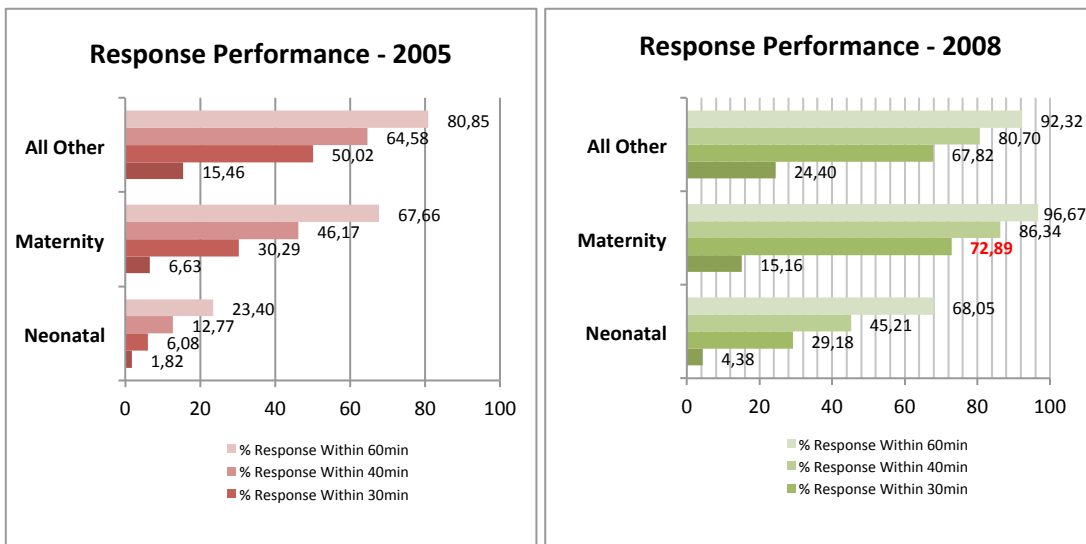
When examining the performance at 30 minutes, the percentage of P1 Neonatal and P1 Maternity incidents improved to 6.1% and 30.3% respectively, while that of the 'All other P1' incidents improved to 50.0%.

In 2008, the performance of P1 Maternity incidents for the 15-minute threshold was still poor with only 15.2% of incidents responded to within the 15-minute target. This was still below that recorded for 'All other P1' incidents (24.4%) (Table 3).

		RESPONSE COUNT	% RESPONSE WITHIN 15	% RESPONSE WITHIN 30	% RESPONSE WITHIN 40	% RESPONSE WITHIN 60
2005	Neonatal	329	1.8	6.1	12.8	23.4
	Maternity	2928	6.6	30.3	46.2	67.7
2008	Neonatal (Flying Squad)	867	4.4	29.2	45.2	68.1
	Maternity (Flying Squad)	3998	15.2	72.9	86.3	96.7

**Table 3:** Response Time Performance at 15, 30, 40 and 60 minute intervals by sub group per year

An analysis of the response performance achieved in the maternity and neonatal incidents for the 15-minute threshold shows that whilst the maternity incidents show a significant improvement ( $p < 0.0001$ ), the improvement in the neonatal response does not ( $p = 0.4212$ ) (figure 6(a)). However, there was a substantial improvement in the response performance for P1 Maternity incidents at the 30-minute threshold, with 72.9% ( $p < 0.0001$ ) of incidents arriving on scene within 30 minutes. This performance is better than that recorded for the 'All other P1' category (Figure 6).



**Figure 6 (a) and (b):** Response Performance as a percentage of total by Case Type per year

This is also reflected in the response performance trend graphs, which demonstrate a greater improvement in response times as shown by the gradient of the trend graph for Maternity incidents (figures 7 & 8).

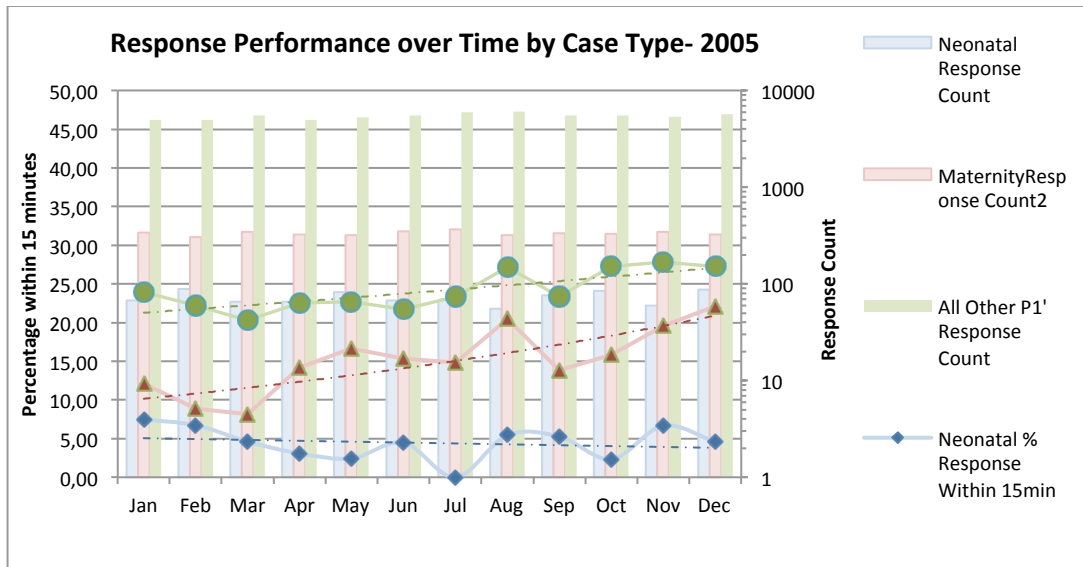


Figure 7: Response Performance over Time by Case Type - 2005

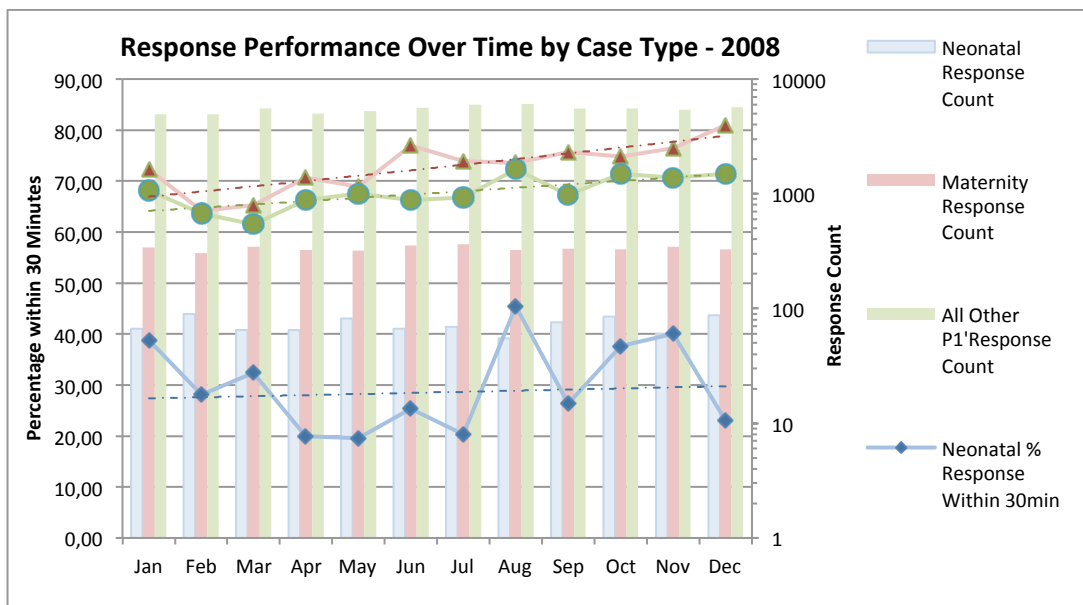
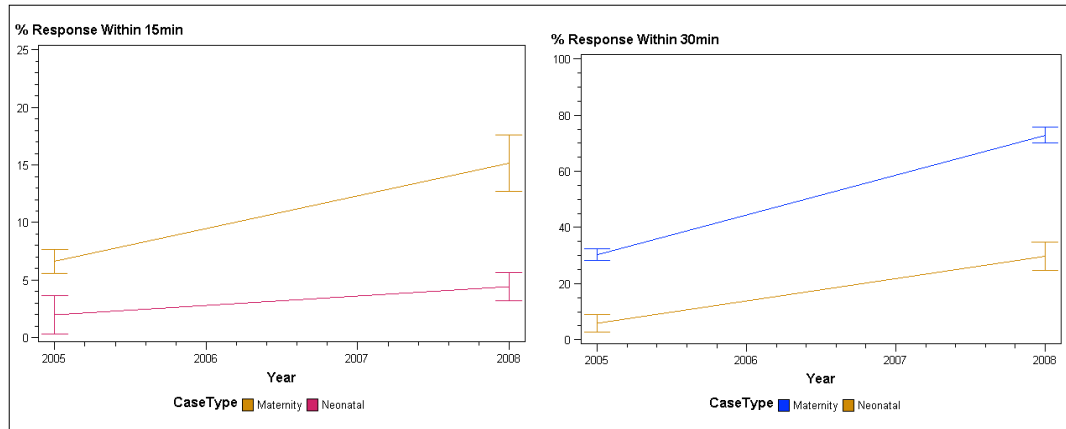


Figure 8: Response Performance Over Time by Case Type - 2008

Again, the P1 Neonatal transfers performed the worst with their 30-minute response percentage recorded as 29.2 %. Although the response performance in the neonatal incidents is still the lowest between the three categories evaluated, there is still a significant improvement in these response trends when the threshold is extended to include the 30-

minute interval ( $p < 0.0001$ ). This interval is also the target that was agreed upon at the inception of the program and is reflected in the Squad's written policy document <sup>[11]</sup>. Figure 9 illustrates the Means plot analysis for the 15 minute and 30 minute response performance by case type per year.



**Figure 9:** Means Plot analysis for % Response Performance within 15 and 30 Minutes by Case Type per Year

### Mean Status Times

Due to missing data elements for the 'time spent at hospital' category, it was not possible to calculate the Mean Mission Time for both 2008 and 2005. Instead, 'time until arrival at hospital' was used as a reflection of the mission time (referred to in this study as 'Total Pre-hospital' time.)

In 2005, the 'total pre-hospital' time for P1 Neonatal transfers was the longest at a mean of 298 min. This was more than twice the mean recorded for P1 'All other' incidents in that same year. Neonatal transfers therefore spent longer in a particular status category than any of the other categories. This trend was seen in all but one of the status categories (mean 'to hospital' time) (Table 4).

The 'time to dispatch' was also significant with a mean of 78 min which was nearly more than double that of P1 Maternity incidents and nearly four times that recorded for 'all other' incidents. In 2005, 'All other' calls displayed the most efficient performance with the lowest mean time recorded in nearly all status categories. P1 maternity incidents were the next best performer with a mean 'total pre-hospital' time of 153 min.

	<b>DISPATCH (A)</b>	<b>TO SCENE (B)</b>	<b>RESPONSE (A + B)</b>	<b>ON SCENE</b>	<b>TO HOSPITAL</b>	<b>TOTAL PRE- HOSPITAL TIME</b>
<b>MATERNITY (2005)</b>	32	21	54	23	22	<b>153</b>
<b>MATERNITY (2008)</b>	10	22	32	26	21	<b>111</b>
<b>NEONATAL (2005)</b>	78	40	120	39	20	<b>298</b>
<b>NEONATAL (2008)</b>	22	34	56	48	24	<b>184</b>
<b>INTER-FACILITY (2005)</b>	58	23	82	33	20	<b>217</b>
<b>INTER-FACILITY (2008)</b>	35	21	55	35	23	<b>169</b>
<b>ALL CALLS (2005)</b>	22	19	42	24	15	<b>121</b>
<b>ALL CALLS (2008)</b>	12	17	29	23	15	<b>96</b>
<b>Service Target</b>	<b>4</b>	<b>11</b>	<b>15</b>	<b>20</b>	<b>10</b>	<b>60</b>

**Table 4:** Mean Time in Status as expressed in Minutes by Case Type per year

In 2008, performance was substantially improved across all categories, with improved mean ‘pre-hospital’ times recorded for all incidents. The greatest change was observed in the P1 neonatal incidents that improved from a mean total pre-hospital time of 298 min for 2005 to 184 min in 2008. This was achieved despite a two-fold increase in call volume. The greatest performance improvement for the P1 neonatal incidents can be seen in the mean ‘time to dispatch’ which was substantially reduced from 78 min in 2005 to 22 minutes in 2008. However, P1 Neonatal transfers still recorded the longest mean status times in most of the status categories.

P1 Maternity incidents improved from a mean ‘total pre-hospital’ time of 153 min in 2005 to 111 min in 2008. Significant in this improvement is the mean time recorded to dispatch the incident. This improved from 32 min in 2005 to 10 min in 2008, which was the lowest time recorded for all the categories. Inter-facility transfers recorded the worst dispatch performance with the mean time to dispatch recorded as 35 min. ‘All other’ incidents still recorded the best overall performance with a mean ‘total pre-hospital’ time of 96 minutes. Figure 10 illustrates the profile of the ‘Pre-Hospital Time’ as well as the mean time spent in minutes within the various status categories per incident type. The reduction in time spent through the life-cycle of a call is clear. This is still substantially below the service target of 60 minutes which is also represented on the Status graph.

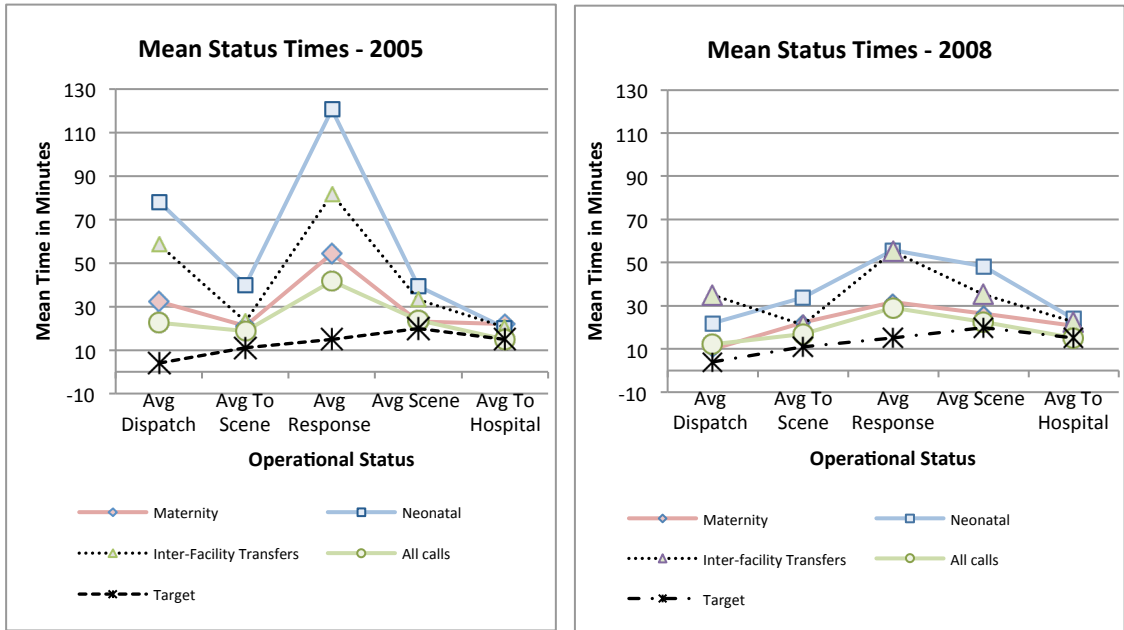


Figure 10 (a) and (b): Profile of Mean Status Times (in minutes) by Incident Type per year

### Workload Trends

Analysis of the trends over both sample periods did not demonstrate any monthly pattern in incident volume for the P1 Neonatal and Maternal incidents. In 2005, December was the month with the highest recorded incidents and January recorded the least with only 211 incidents captured. In 2008, July was the busiest month for the Flying Squad with 434 incidents responded to while August recorded the least number of incidents (Figure 3).

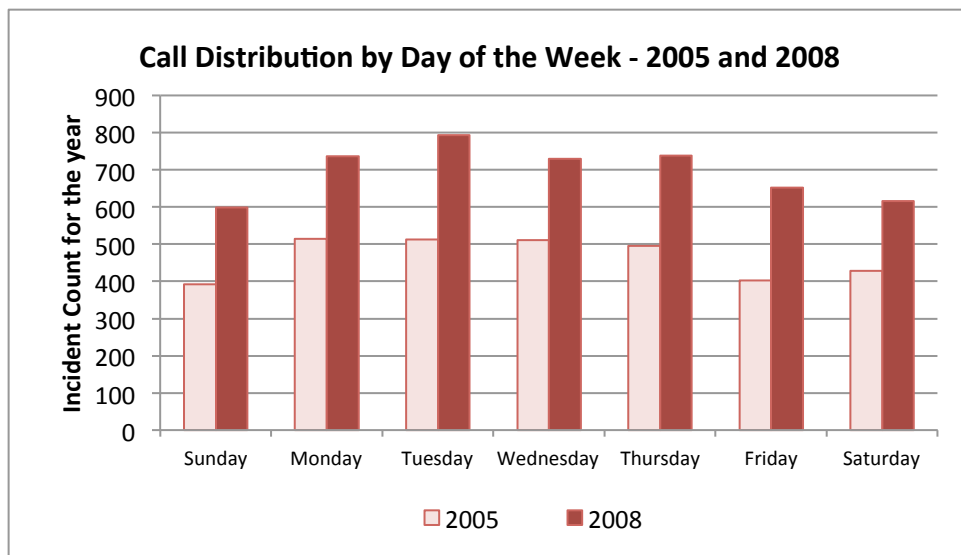
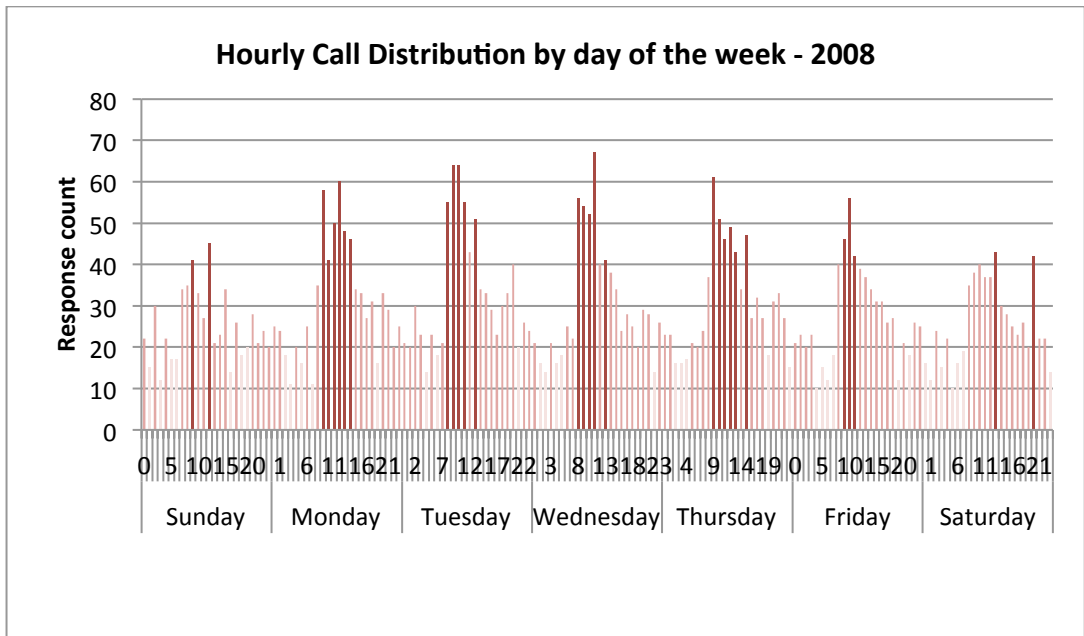
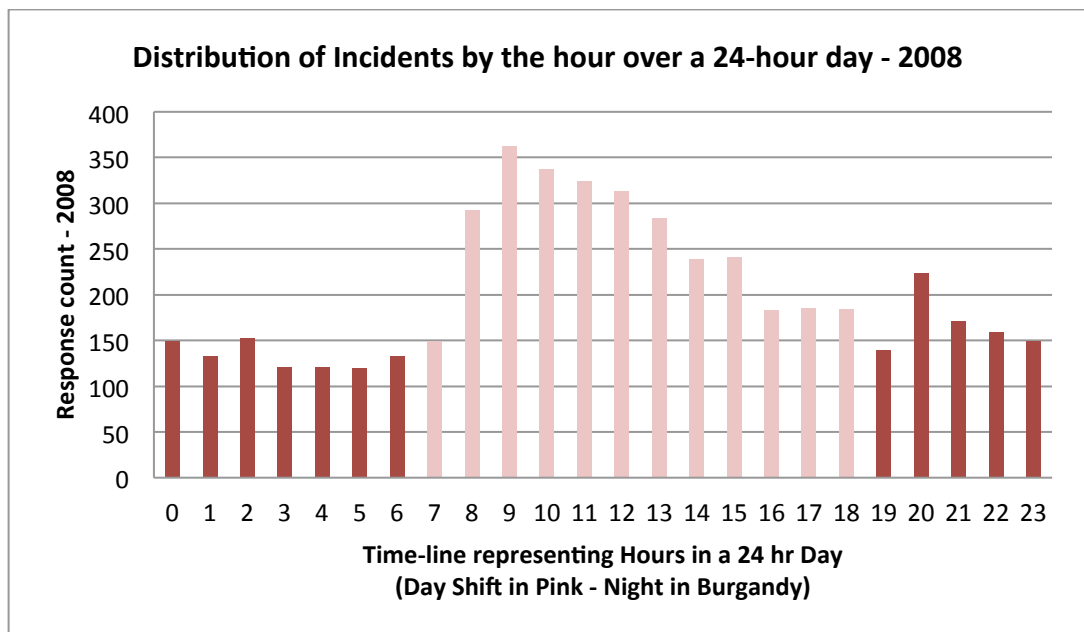


Figure 11: Call distribution by day of the week -2005 and 2008

Figure 11 shows that Tuesday was the busiest day in the week (2005 and 2008), while Saturday and Sunday had the least number of incidents captured for both sample periods. Analysis of the incidents by the time of the day that the call was received reveals that the bulk of the incidents are received during the day shift (Figure 12 and 13).



**Figure 12:** Call Distribution by the hour, per day in the week for 2008



**Figure 13:** Distribution of Incidents by the hour illustrating Day and Night Shift call volumes

In 2008, nearly two-thirds (66.5%) of the incidents were captured between 07h00 and 19h00 (Figure 13). Between 09h00 and 12h00, requests for Flying Squad transfers was the highest, while 03h00 and 06h00 was the quietest period for the Flying Squad with the least number of incidents captured. A spike in the number of incidents captured is observed at 20h00 - a likely explanation for this phenomenon lies in the fact that many of the Mid-wife Obstetric Units have a scheduled shift change and hand-over ward round at 19h00.

### Completion Codes

The completion codes for the two sample periods reveals that the bulk of these transfers were taken to Level 2 and Level 3 health facilities. Mowbray Maternity, Groote Schuur and Tygerberg were the health facilities receiving the most patients (Table 5).

RECEIVING FACILITY	RESPONSE COUNT - 2005	RESPONSE COUNT - 2008
Mowbray Maternity	949	1380
Groote Schuur	917	1369
Tygerberg	268	935
New Somerset	323	433
Karl Bremer	207	218
Red Cross Children's	0	166

**Table 5:** Completion Codes for Receiving Facility 2005 and 2008

The sudden increase in patients transported to Red-Cross Children's hospital (RCCH) can be explained by the creation of the paediatric flying squad case type. Prior to this, incidents were not captured under this designation but were categorised by the underlying pathology.

The increase in the patients transported to New Somerset Hospital (NSH) can also be explained by a change in the referral boundaries between NSH and RCCH. This was done in order to provide some relief to the tertiary facility during the diarrhoeal 'season'.

COMPLETION CODE	RESPONSE COUNT - 2005	RESPONSE COUNT - 2008
Born Before Arrival	139	146
Cancelled	9	54
Ambulance Not Required	27	41
Other Transport	14	19
Dead On Arrival	5	26
No Patient Found	12	6
Double Request	4	11
Other	21	23

**Table 6:** Completion Code for Non-facility related incidents – 2005 and 2008

In 326 (6.7%) of the incidents in 2008 and 231 (7.8%) of the incidents in 2005, transport to a facility was not the outcome of the response (Table 6). The majority of these (146 in 2008 and 139 in 2005) were incidents where the baby was born prior to the arrival of the ambulance. This accounted for 3% of all calls received in 2008 and 5% of all calls received in 2005.

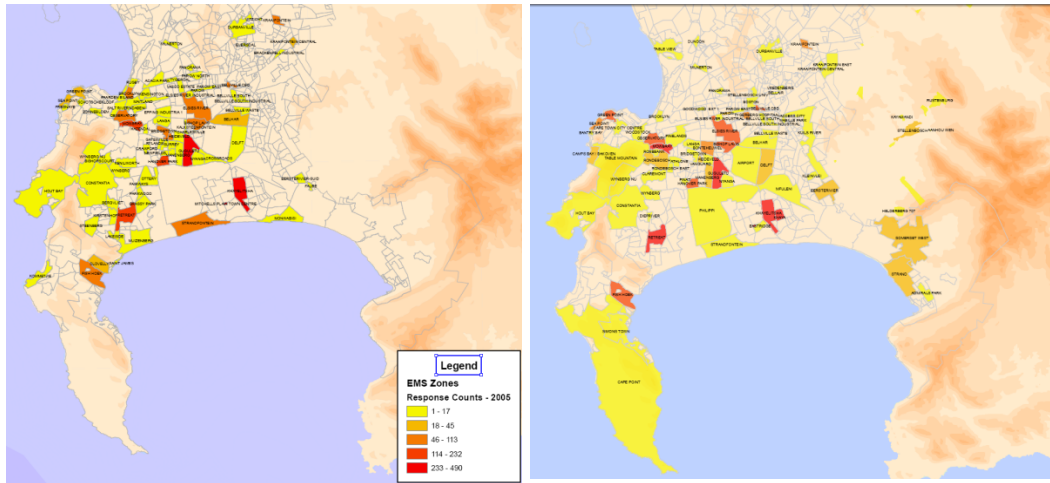
Of concern is the increase in 2008 in the number of calls that were cancelled by the caller or by the referring health facility prior to the arrival of the ambulance. Although this number is small (1.1% of all incidents) the sudden increase is significant when compared to that received in 2005.

### **GIS data**

GIS data were also recorded for the incidents received and these were mapped using GIS software. The resulting polygons were then colour graded to reflect those incidents with the highest call rate for both 2005 and 2008 (*Figure 14 – for more detailed map see Appendix D and E*).

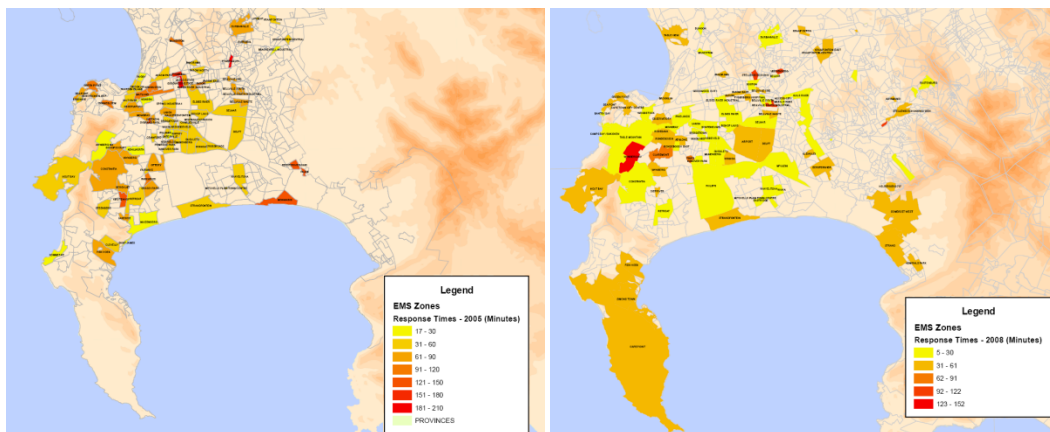
Examination of the maps would reflect that Khayalitsha, Mowbray, Hanover Park and Manenberg were the suburbs that recorded the highest incident rate in 2005. In 2008, the picture is very similar with Mowbray, Khayalitsha and Guguletu again featuring prominently with the addition of Retreat.

In many respects the maps are very similar with only slight variation in the call rates between suburbs. Thus, there were no substantial changes in the catchment areas from which the incidents were captured.



**Figure 14 (a) and (b):** GIS data illustrating Incident distribution by Suburb per year (a =2005, b = 2008)

A second set of maps was generated to illustrate the response time performance for the same areas in each of the two sample periods (*Figure 15 – for detailed map see Appendix F and G*). By comparing the 2005 and the 2008 data, the improvement in response times within the different areas is evident.



**Figure 15 (a) and (b):** GIS data illustrating 15 Minute Response time performance by Suburb per year (a = 2005, b = 2008)

Noteworthy is the change in the number of suburbs that recorded a response time of less than 30 minutes in 2008 and their proximity to the health facilities receiving the highest call volume viz. Tygerberg, Groote Schuur and Mowbray Maternity hospital. The 2008 response time map graphically illustrates the improvement in performance recorded for the P1 Neonatal and Maternity Flying Squads.

## DISCUSSION

### Study Outcome

The purpose of this study was to determine whether the establishment of a dedicated obstetric and neonatal flying squad had resulted in improved performance within the setting of a major metropolitan area.

The results indicate that between 2005 and 2008, the service had made significant improvements in its performance across all incident categories as is reflected by the improvement in the 'all other P1' categories.

The reason for this performance is likely to be found in the improved resources both in terms of staffing and of equipment. In addition, general improvements in operational structures, management capacity and personnel management may have contributed to this improvement. It should also be borne in mind that EMS by its very nature is the critical link in a system that is focused at delivering health care to the public, and as such, improvements and changes made in this sphere would affect EMS. Therefore, improvements observed in the general ambulance operations may reflect improvement throughout the health system. It is on this basis that the Western Cape EMS has often referred to its approach as not providing an emergency medical service, but rather an emergency medical system.

This study indicates that while improvement was observed across all incident categories, the improvement within the Neonatal and Obstetric cadre has been greater than that experienced in the general ambulance operations. The introduction of the Flying Squad programme has therefore resulted in significant improvements in the performance of

obstetric and neonatal incidents. In the analysis of this finding, several other aspects of the programme need to be explored.

## **The Strategy**

The process adopted in the introduction of the Flying Squad model is significant to understanding its success. The engagement of key stakeholders early on, as well as their continued involvement throughout the implementation and evaluation phase, was crucial. Therefore, ownership of the programme was ensured and facilitation of meeting its principle objectives would be the responsibility of all involved. This resulted in the development and acceptance of the criteria upon which the dispatch of the squad would be based.

An example of this model of engagement occurred earlier on in the efforts of the ECC to address aspects of resource 'misuse' on the part of the clinics and Midwife Obstetric Units (MOU). Shortly after the introduction of the program, the referring facility would often request a transfer based loosely on the criteria, but which in reality was merely aimed at getting a faster response. The ECC then invited key personnel to the centre to introduce them to the workings of the centre and discuss the misuse of the centre. The resultant improvement in relations led to a reduction in the incidence of misuse.

## **Dispatch**

One of the greatest challenges in evaluating performance in the pre-hospital arena, particularly in the South African context, has been the paucity of reliable data. This challenge is being met with the introduction of Computer Aided Dispatch (CAD). CAD has

been the single most significant advance in the local industry in recent times and has led EMS managers to take a fresh look at each aspect of operations.

Resource utilisation is one of the key aspects underlying efficiency in any pre-hospital service and is the basis of all decision making in the modern ECC. It is in the analysis of the findings around dispatch where the greatest impact of the Flying Squad program is most apparent. The dramatic increase in the percentage of calls dispatched within 4 minutes is responsible for the bulk of the performance improvement.

This is evident in the improvement in the 'Status' times that saw the mean neonatal dispatch time decrease from 78 minutes to 22 minutes. Maternity times improved from 32 minutes to 10 minutes, which was the fastest mean dispatch time out of all P1 incidents evaluated. However, this study has raised some concerns around the capacity of the data management processes that would need to be addressed if EMS is to continue to maximise the potential of CAD. The non-availability of information around hospital and mission time is one such concern.

Another aspect of the process that influences the success is while it focused on ring fencing of the ambulance and its staff, it had in fact also ring fenced the dispatch of the resources as well. Efficiency of resource utilisation is built on the dispatcher's decision-making acumen, which in turn is determined by the quality and the accuracy of the information obtained. By determining the manner in which an incident is captured and evaluated (i.e. the development of predetermined criteria for dispatch), the programme has resulted in a more accurate and less vague form of communication. The result is greater dispatcher confidence and more accurate, rapid and appropriate dispatch. This is evident in the substantial improvement in both the neonatal and maternity's percentage of dispatched incidents in less than 4 minutes.

Perhaps one of the key questions that the study raises, and one that needs to be explored in later studies, is the question concerning dispatcher bias. Solely the dispatcher determines which resource to activate and which P1 incident to dispatch. He/she uses their experience and judgement to prioritise P1 incidents before dispatching them. It is suggested that in the case of neonatal and maternity incidents, the fact that these patients are already accommodated at a health facility has led many dispatchers to defer their dispatch in favour of a primary response (such as to a road accident or patient's home). This observation is supported by the fact that in the case of the inter-hospital transfer category, the mean time to dispatch is still long at 35 minutes - the poorest recorded mean for all the categories that were examined.

However, despite the improvements, there are still some substantial gains to be made. It is of concern that even after extending the dispatch threshold to 10 minutes, 15% of the maternity and 45% of all neonatal incidents were yet to be dispatched. In nearly half of the neonatal cases, more than one-third of the available response time is utilised in the dispatch phase of the call. Much effort and attention at the dispatch of these incidents is required, if the target of completing all neonatal incidents within 30 minutes is to be realised.

## **RESPONSE**

Response time was the second process measure that was examined and it too demonstrated a significant improvement across all the incident categories evaluated. While an improvement was observed in the 15-minute response performance for maternity incidents, the improvement in the neonatal category was not found to be statistically significant.

It is only once the 30-minute threshold is used, that we see a significant improvement in the neonatal incident response performance. An explanation for this may be found in two important aspects of ECC's operations. The first was alluded to in the previous discussion around dispatch. If more than half the incidents are still to be dispatched at 10 minutes, it is unlikely that the performance at the 15-minute threshold will show any great advances. In this regard, poor dispatch performance will inevitably result in poor response performance.

A second reason for this finding can be found in the policy document of the Flying Squad. Part of the strategy employed was to assure the stakeholders that all Flying Squad incidents will be responded to within 30 minutes. This process of managing the stakeholders expectations ensured that the squad was able to deliver on a considerable part of its mandate. Both dispatcher and ambulance crew could now target this more realistic 30-minute threshold. The result of this is evident in the maternity incidents with the dramatic improvement in the 30-minute response time performance from 30.3% in 2005 to 72.9% in 2008.

Neonatal transfers achieved a mean response time of 56 minutes in 2008 (120 minutes in 2005). The lack of available benchmarking as well as the vague definition of response times renders any meaningful comparison with times observed in other studies, difficult. Whilst both *Kempley et al* and *Abdel-Latif* have reported median response times for neonatal transfers of 85 and 75 minutes respectively, this cannot be used as a comparison for performance achieved in this study<sup>[32, 56]</sup>. Both used 'response time' as a measure from the initial discussion with the receiving facility to what they referred to as the 'first look'. They do however provide an indication of the time frames involved in executing these transfers.

A further reason for the improvement in the maternity incidents lies in the strategic shift that was made early on in the design of the Flying Squad operating procedures. The reason

for this shift is in the differences between the neonatal and obstetric transfer requirements. Obstetric emergency transfers require rapid evacuation of a patient from the primary health care facility to a level 2 or level 3 facility. In addition, they have very few specialised requirements in terms of equipment, vehicles or the health care practitioner's particular skill set. The 'scoop and run' approach is thus often adopted in executing these transfers.

In contrast, neonatal transfers have very specific requirements where safety is as important as speed of transfer. Specialised equipment is needed in terms of incubators, transport ventilators, medication and infusion pumps. The Advanced Life Support skills required to perform these transfers safely are also in high demand, further hampering a speedy execution of the transfer request. This aspect, together with the high incidence of adverse events, has meant that services need to adopt a 'stay and play' policy when dealing with these incidents. It is on this basis that the Flying Squad included in its strategy a differential response for maternity and neonatal incidents. This evolved into the use of two intermediate crews to perform the maternity transfers while the ALS crew was reserved to attend to all the neonatal and critical obstetric transfer requests.

A further example of the use of resource mapping to better meet the demands placed upon the service can be seen in the shift model that was applied to the programme. By determining the peak workload and demand trends, the shift system was adapted to enable 24-hr maternity cover while the ALS neonatal and obstetric service was limited to daylight hours. Any urgent neonatal transfers requested at night were completed by the general night-shift ALS service.

These strategies ensured that resource usage was optimised in an effort to meet the demands with greater efficiency. The result is improved response time performance. Greater efficiency was not only seen in the dispatch and response time performance but is also evident in the analysis of the mean status times for each of the case type categories.

Most notably is the status time of the neonatal incidents in which was observed the longest mean 'On-scene' time in both 2005 and 2008, despite the significant improvement in response time performance as mentioned earlier. *Kempley et al* and *Abdel Latif* also made this observation in their analysis of retrieval teams and their performance<sup>[32, 56]</sup>. The reason for this is likely due to the specialised nature of the neonatal calls already alluded to earlier in this discussion. In the Flying Squad programme, this was addressed by cultivating the skill set possessed by the crew during their 6-month rotation.

A further initiative was to ensure that each ALS crew were adequately equipped with the necessary equipment needed to execute the neonatal transfers. This avoided the ambulance having to waste precious time in attempting to locate a neonatal ventilator or working incubator. The allocation of a dedicated ambulance ensured that vehicle downtime was minimised as the crew had a greater sense of ownership and therefore took greater care. These measures ensured greater efficiency and culminated into a reduced 'Pre-hospital time'.

An indication of the overall improvement in the process measures lies in the reduction of the total 'Pre-hospital time'. This is a culmination of the times spent in each of the various status categories. A drawback of this study lies in that it could not evaluate total mission time, and had to substitute it with the 'Pre-hospital' time. This, while still being of value as a gross measure of efficiency, does not fully represent the interaction with the Health facilities.

Mission time is a very comprehensive measure of efficiency and probably better reflects performance than response time does. It accommodates the impact that the health system has on EMS performance as a whole by indirectly measuring two key components. The first is in the appropriateness of the facilities in relation to the location of the incident (a sort of health service 'footprint') by evaluating the time taken in travelling from the incident to the

appropriate health facility. The second is the efficiency of the health facility to process the patient's reception upon arrival, by measuring the hospital time.

## **LIMITATIONS**

One of the key limitations in this study is that while it has focused on assessing process measures, patient outcomes were not evaluated. Although the study demonstrates a significant improvement in dispatch and response times, the absence of patient outcome measures has limited the conclusions that can be made. Teams may certainly have executed these transfers more efficiently, but the appropriateness of the dispatch or the quality of the clinical management cannot be determined. It therefore cannot be determined if the introduction of the Flying Squad programme provided a better level of care, which was one of the programme's key objectives.

The Flying Squad programme does not 'stack' calls. This means that when two requests are received simultaneously, only one is allocated: a second resource is then utilised from the general ambulance operations in order to service the second call. This is part of the operating procedures for the Flying Squad, and a measure of its impact on the level of service provided is desirable. However, the frequency with which this occurs is not recorded, and therefore the impact that this has on the improvement in performance cannot be measured.

A further limitation lies in the failure to determine the time spent at the hospital during handover. In so doing, a critical component of the transfer process was ignored. Therefore, the role that the hospital has to play in enabling greater efficiency was not examined. However, during discussions at Flying Squad meetings, clinicians from referral and receiving

facilities anecdotally have made no changes in standard practices when receiving these patients.

## CONCLUSION

The merits of a specialised retrieval team have been well established, and have been met with generalised acceptance by health care systems in developed countries. The question that faces developing nations is whether or not such a programme has any role to play, taking into account the significant challenges they face in terms of struggling health care systems, poorly resourced services, significant socio-economic burdens and poorly developed infrastructure.

The findings in this study indicate that there are significant gains to be made by developing countries through the introduction of specialist retrieval teams. The proof resides not only in the greater efficiency that it stands to benefit from, but also in understanding the operational forces that influence performance. This study has not only quantified the degree of efficiency that can be achieved, but has also highlighted several key workflow processes that are integral to performance. The evidence in support of retrieval teams is beginning to mount and health care managers in developing countries need to start considering these programmes as essential components of a developing health care system.

## RECOMMENDATIONS

Based on the findings of this study the following recommendations are made:

1. The programme be expanded into all major metropolitan services, especially those that have a tertiary package of neonatal and paediatric care.
2. The programme should be piloted in rural areas to determine the appropriate model that applies.
3. That consensus is obtained from all major stakeholders around the definitions and terminology that should apply to these programmes, and that this forms the basis for a formalised process of evaluation and benchmarking.
4. That more extensive research is commissioned into examining both the process and patient outcome measures, and that these also focus on the establishment and validation of a morbidity and/or mortality score based on the dispatch criteria of the METRO EMS Flying Squad programme.
  - This score would then permit greater accuracy in terms of communicating the priority of the transfer and guide dispatch decision making.
5. To adequately address aspects of training and quality management of the team's activities, greater effort on the part of programme managers concerning resourcing and staffing of the unit is required.
  - A key component to the implementation of a successful specialist retrieval program lies in the composition of its team. One of the failings was the inability of the programme to embed the EMS practitioners into the intensive care unit.



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## APPENDIX

**A** \_\_\_\_\_ **NEONATAL FLYING SQUAD**

*Call out pathway for referring unit*

**B** \_\_\_\_\_ **MATERNAL FLYING SQUAD**

*Call out pathway for referring unit*

**C** \_\_\_\_\_ **PAEDIATRIC FLYING SQUAD**

*Call out pathway for referring unit*

**D** \_\_\_\_\_ **2005 GIS DATA (Figure 14a)**

*Illustrating incident distribution by suburb*

**E** \_\_\_\_\_ **2008 GIS DATA (Figure 14b)**

*Illustrating incident distribution by suburb*

**F** \_\_\_\_\_ **2005 GIS DATA (Figure 15a)**

*Illustrating 15-minute response performance by suburb*

**G** \_\_\_\_\_ **2008 GIS DATA (Figure 15b)**

*Illustrating 15-minute response performance by suburb*

## APPENDIX A

### NEONATAL FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT

#### BABY MEETS FLYING SQUAD CRITERIA

- Call the receiving hospital and check for bed availability.
- Once you have a bed, call **Metro on 937 0300**.
  - Ask for the NEONATAL FLYING SQUAD.
- Metro will ask you for the criteria under which your patient falls. Tell them which one from the list.
- The ambulance should be with you within **30 minutes**.
  - If not, call back every 30 minutes until the ambulance arrives.

#### **FLYING SQUAD CRITERIA**

- Birth weight <1600g
- Respiratory distress requiring Oxygen
- Cyanosis
- Meconium aspiration
- Recurrent apnoea
- Convulsions
- Clinical evidence of systemic infection
- Hypoglycaemia not responding within 30 minutes
- Babies requiring intubation for resuscitation at birth
- Shocked babies
- Babies who are bled out
- ICU to ICU transfer
- Intubated babies or failed intubation requiring BVM ventilation
- Babies with underwater drains
- Bile stained vomit
- Surgical problems requiring urgent surgical attention

#### BABY DOES NOT MEET FLYING SQUAD CRITERIA

- Call the receiving hospital and check for bed availability.
- Call **Metro on 937 0500**. Ask for an emergency transfer.
- Tell Metro the indication for the transfer from the list below.
- For **PRIORITY 1B**, the vehicle should be with you within **1 hour**. If not, call back to Metro and ask for an update.

#### **PRIORITY 1B CRITERIA**

- Persistent vomiting
- Birth weight 1600-2000g
- Jaundice:
  - >200 µmol/l day 1
  - >400 µmol/l at any time: normal birth weight
  - >300 µmol/l at any time: low birth weight
- Any infant with a delay of more than 2 hours from first call

- For **PRIORITY 2**, the vehicle should be with you within **2 hours**. If not, call back to Metro and ask for an update.

#### **PRIORITY 2 CRITERIA**

- Other

### NEONATAL FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT

## APPENDIX B

### MATERNAL FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT



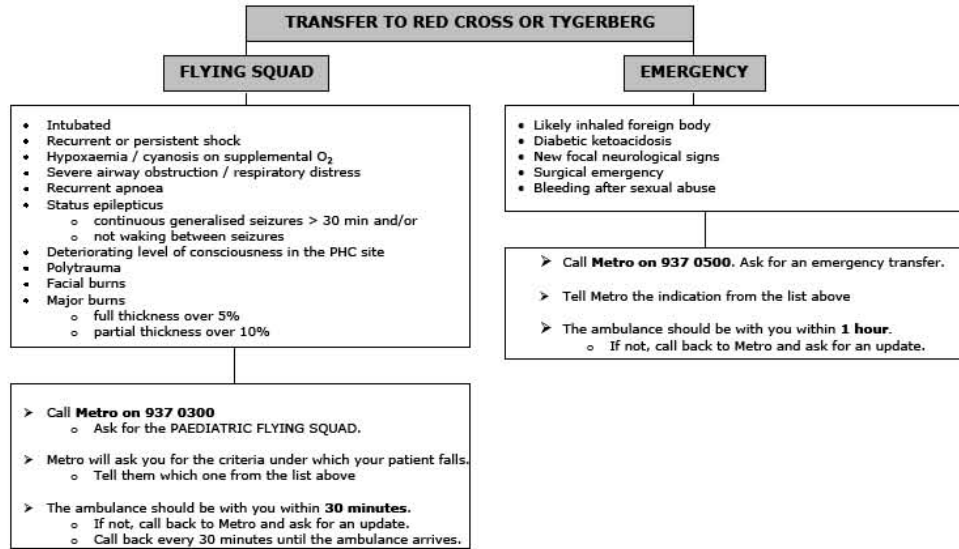
- Call the receiving hospital and check for bed availability.
- Once you have a bed, call **Metro on 937 0300**.
  - Ask for the MATERNAL FLYING SQUAD.
- Metro will ask you for the criteria under which your patient falls.
  - Tell them which one from the list below.
- The ambulance should be with you within **30 minutes**.
  - If not, call back to Metro and ask for an update.
  - Call back every 30 minutes until the ambulance arrives.
- Contact Prof Coetzee at GSH to update him that you have used the Flying Squad service. The office number is 021 4046020.

#### FLYING SQUAD CRITERIA

<i>Indication</i>	<i>Receiving unit</i>
<i>Maternal: ante-partum</i>	
• APH with Suspected abruptio	GSH / TBH
• APH with suspected placenta praevia	GSH / TBH
• Pre-eclampsia in labour	GSH / TBH
• Severe pre-eclampsia <ul style="list-style-type: none"> <li>○ DBP &gt;109 on 2 readings AND 2+ or more proteinuria</li> <li>○ AND symptoms (severe headache, epigastric pain, eye symptoms))</li> </ul>	GSH / TBH
• Eclampsia	GSH / TBH
• Cardiac arrest	GSH / TBH
• Ventilated	GSH / TBH
• Pulmonary oedema	GSH / TBH
• Status asthmaticus	GSH / TBH
• Status epilepticus	GSH / TBH
• Known cardiac in labour	GSH / TBH
• Known diabetic in coma	GSH / TBH
• Delayed progress, >7cm dilated	SECONDARY CARE
• Prolapsed cord	SECONDARY CARE
• Breech, >7cm dilated	SECONDARY CARE
• Other abnormal presentations in labour	SECONDARY CARE
• Pre-term labour with dilated cervix (<32 weeks)	SECONDARY CARE
• Previous c. section, in labour	SECONDARY CARE
• Pre-term labour, <34 weeks	SECONDARY CARE
<i>Maternal: Post partum</i>	
• Post Partum Haemorrhage	GSH / TBH
• Uterine inversion	GSH / TBH
<i>Foetal</i>	
• Foetal distress (late decelerations)	SECONDARY CARE
• Undiagnosed retained twin	SECONDARY CARE

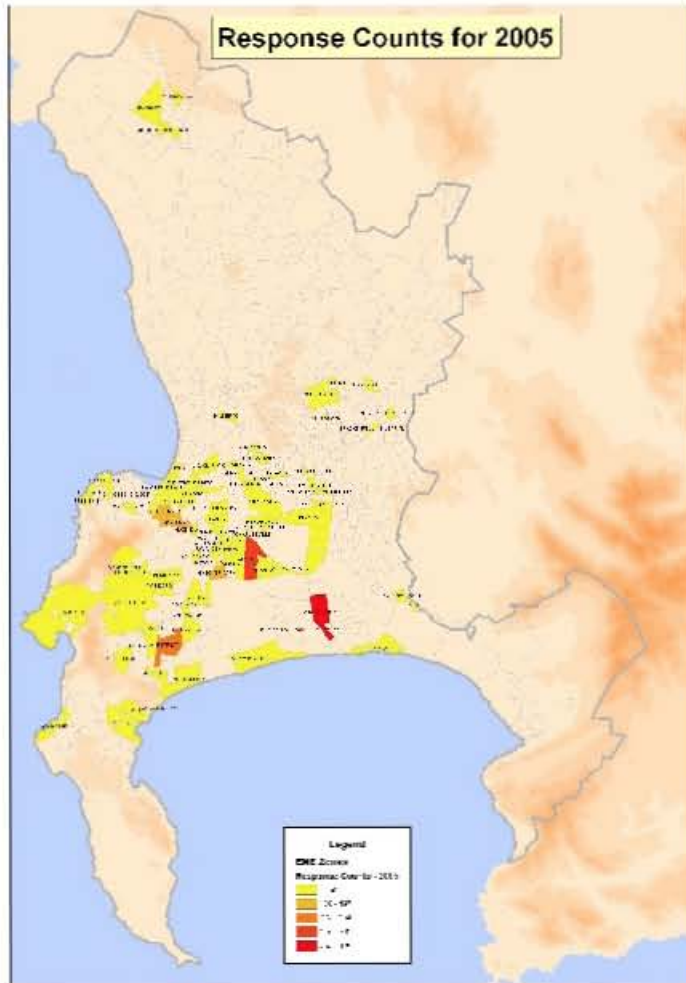
### MATERNAL FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT

PAEDIATRIC FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT

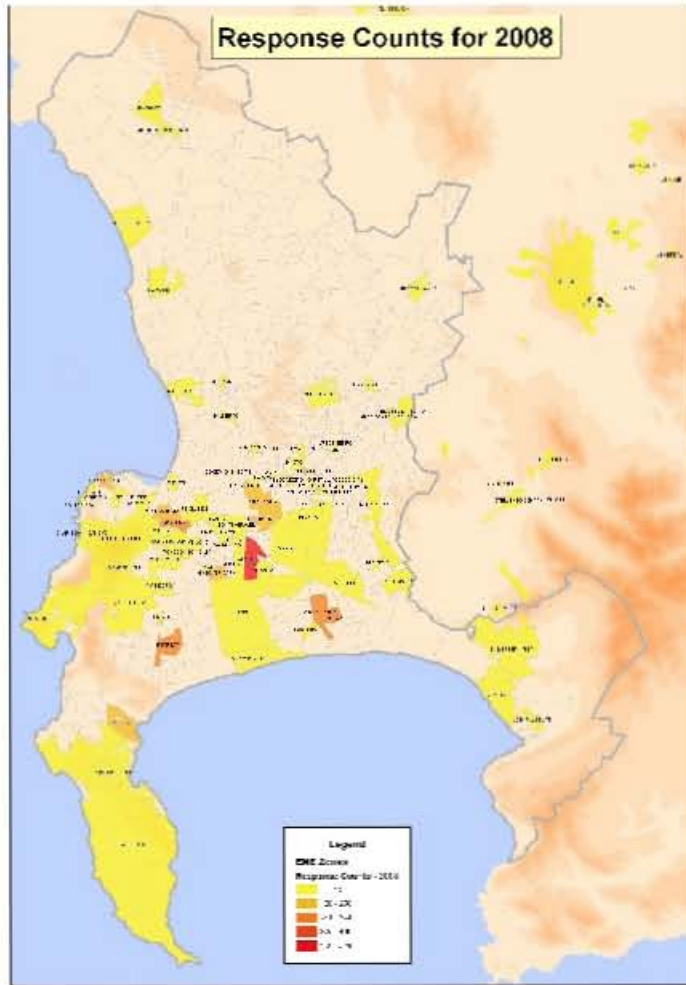


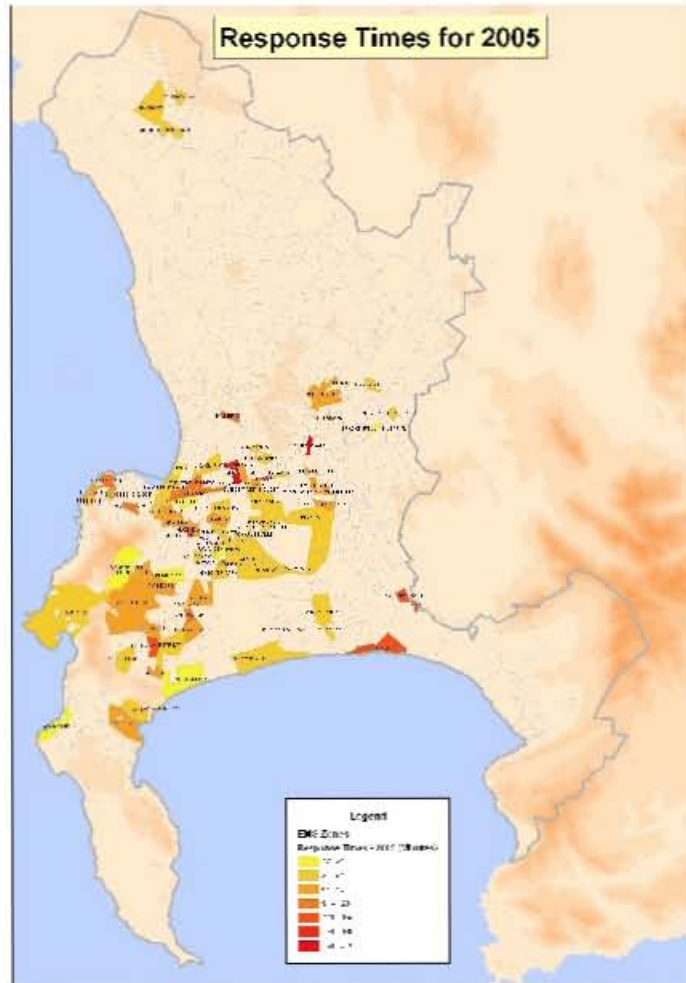
PAEDIATRIC FLYING SQUAD – CALL OUT PATHWAY FOR REFERRING UNIT

APPENDIX D



APPENDIX E





APPENDIX G

