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ORIGINAL ARTICLE

Measuring Obstetric Anaesthesia workload – Empirical research using a Mixed Methods Design as part of a Quality and Safety Improvement Project

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Background

Obstetric anaesthetists at Mater Dei Hospital considered the quality and safety of their work was deteriorating due to increasing workload. Literature suggests various ways of measuring this including the delivery rate, caesarian section rate, epidural rate, the obstetric anaesthesia activity index or a combination.

Objectives

The objectives were; to define the obstetric anaesthesia workload; to benchmark to standards set by international bodies; and to make evidence-based recommendations to improve safety and quality.

Methods

This single-centre study was performed between September 24 and November 20, 2017. It was an empirical research study using a mixed methods design. This allowed for data triangulation. Data was analyzed using SPSS.

Results

In 58 days, there were 669 births, 198 (29.6%) of which were by a lower segment Caesarean section (LSCS). On 30 days (52%), elective work over-ran, adding to the on-call workload. Average theatre cases in 24-hours were 3.81 ± 1.55. Epidural rate was 28.4% (*n*=190). The mean number of epidurals in a 24-hour period was 3.28 ± SD1.609. On 7 days (12%), not all requested epidurals were done because the anaesthetist was busy. Significant "hidden workload" was identified including patient reviews on 39 days (67%), vascular access outside theatre on 21 days (36%) and stand-by requests on 29 days (50%). There was no statistically significant difference between the work done on weekdays versus weekends.

Conclusions

We identified a significant amount of "hidden workload" in obstetric anaesthesia and workflow inefficiencies. Recommendations are being implemented to increase quality and safety of obstetric anaesthesia in Malta.

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Introduction

Malta is a Mediterranean island state with a population of around 470,000 people. It is currently experiencing a rapid population expansion due to immigration: a staggering 39% increase per 1000 inhabitant compared to an EU average of 2.1% per 1000 inhabitant.[1] It is mainly served by one tertiary general hospital with a 20-bedded intensive care unit, a theatre complex with 20 operating rooms and a labour ward with 9 suites and its own operating room.

Data from 2016 revealed a total of 4455 deliveries, the highest figure since 2000.[2] Delivery by Caesarean section was at 30.7% of all deliveries, up from 23.1% in 2000; 86.5% of these were done under a regional anaesthetic.[2-3] In 2014, epidural analgesia uptake stood at 26% of all deliveries, up from 6% in 2003.[3] Both the number of deliveries and the requests for anaesthetic procedures are set to continue increasing.

Obstetric anaesthesia is delivered by one on-call anaesthetist doing a 24-hour shift with dedicated consultant cover and junior trainee support from Monday to Saturday in the morning until 2PM. The on-call anaesthetist is either a non-consultant specialist or a senior trainee. Duties in obstetric anaesthesia are deemed notoriously work-intensive and anaesthetists during 24-hour shifts in labour ward often complain about the difficulty in delivering a safe service because of being over-worked and too tired. In addition, there is no separation of elective and emergency theatre work: both are carried out by the same anaesthetic team in the single labour ward operating room.

The aims of this study were to carry out a literature review of how anaesthetic services should be delivered in an obstetric setting; to carry out a literature review of how "workload" is assessed; if these do not return any results, or the methods identified therein are not feasible in our setting, set up a method to quantify and assess "workload"; assess the workload in our delivery suite using the parameters identified in earlier stages; and submit evidence-based recommendations to the departmental management for evaluation and implementation. This initiative served as a quality and safety improvement project in obstetric anaesthesia in Malta, following the concept of Safety-2, a model that aims to improve systems and processes to prevent the occurrence of errors or mistakes, rather than waiting for errors to occur and analysing them in retrospect (Safety-1).[4-5]

Materials and Methods

Permission to carry out this study was sought from, and granted by, the chairpersons of the departments of Anaesthesia and Intensive Care and of Obstetrics and Gynaecology, and the Data Protection Office, all at Mater Dei Hospital. Approval by the University of Malta Research Ethics Committee was not deemed necessary, as this was an internal data collection exercise with no patient involvement or intervention. The purpose of the study was explained to all anaesthetists working in obstetrics in writing and they all consented to participating in telephone interviews as part of this project.

A literature search was carried out to identify documents on the provision of anaesthetic services especially in obstetric anaesthesia. This was particularly important to select quality of care markers to which the obstetric anaesthesia service in Malta could be

compared. Also, a search for the terms "health workload", "workload in healthcare", "workload", "assessment of workload" was carried out on PubMed and Google Scholar.

The mixed-methods study design was used to develop a model to collect data in our setting and this included data triangulation, complementarity and expansion, three of the five main components of mixed method research.[6]

The first step in designing this study was to identify functioning databanks that were already in use and with which all labour ward staff were familiar. These were the operating theatre register, the obstetric anaesthesia activity logbook, the epidural analgesia record and the mothers' clinical notes. Although these involved writing down information manually, they were all filled out contemporaneously and their use was very well established. These databanks were used to devise a method to collect quantitative data that involved one databank serving as a primary source and another to cross-check it.

In addition, a number of activities that take a considerable amount of time but are never recorded were identified. These were: (1) standby for instrumental deliveries, (2) postoperative review of patients and (3) obtaining vascular access outside theatre. There were collectively termed "hidden workload". Interviewing the on-call anaesthetists was deemed the ideal way to gauge the amount of this work.

Three separate data collection protocols were written up each covering a different aspect of workload in obstetric anaesthesia. Analyzing the data from the three protocols together would allow building up an understanding of what was going on in labour ward. The protocol forms were:

- *Anaesthetist on-call questionnaire* – included questions on the work they did, including the hidden workload, and whether they felt subjectively busy during various shift times. This data was collected by one-to-one telephone interviews with on-call anaesthetists in the final thirty minutes of their 24-hour shift.
- *Epidural analgesia service workload* – included the grade of performing anaesthetist, the time of epidural request and the time of test dose administration for every epidural inserted in the previous 24-hour duty. Data was collected and cross-checked from the epidural record book, the anaesthesia procedures logbook and the midwifery notes.
- *Labour ward operating theatre workload* – included details on each individual theatre case, especially their timing, duration and level of urgency. Data was also collected on whether any cases had to be done in the main operating theatres (MOT), particularly the indication mandating such a transfer. This data was collected and cross-checked from the labour ward and MOT theatre registers, and the anaesthesia procedures logbook.

A working group consisting of anaesthetists with varying levels of experience was set up to serve both as a focus group and data collectors. Its members were informed about the purposes and methods of the initiative and trained in the completion of paper data collection forms. Three data collectors were assigned to a specific protocol i.e. one each for theatre cases, epidural service and anaesthetist on-call. A fourth was assigned to fill up gaps in cases of unavailability. Instructions on following the data collection protocols were written up overleaf on the

forms to serve as an aide-memoire and to further ensure standardization in data collection.

The project ran for 58 consecutive days (from September 24 to November 20, 2017) and data was collected prospectively every day. After the first three weeks, the working group was re-convened to discuss how data collection was progressing and deal with any problems. The unanimous decision was to continue with the data collection as planned with no changes to the protocols in place.

The data collected was inputted in MS Excel spreadsheet by one other member of the working group and was then analyzed by a separate professional statistician using SPSS.

RESULTS

The literature review identified three documents to be consulted for benchmarking our service: the OAA/AAGBI Guidelines for Obstetric Anaesthetic Services 2013, the Royal College of Anaesthetists Guidance on the Provision of Obstetric Anaesthesia Services 2019 and the WHO-WFSA International Standards for a Safe Practice of Anaesthesia.[7-9] At the time of writing, no similar European guideline was available. The authors are however aware of an ongoing effort by the European Board of Anaesthesiology to produce such recommendations (private correspondence).

Publications on evaluation of obstetric anaesthesia workload are limited. The 2005 AAGBI/OAA joint report arbitrarily defines "busy units" as those with over 5000 deliveries per year, an epidural rate above 35% and a Caesarean section rate above 25%.[10] Ginosar and colleagues devised the Obstetric Anaesthesia Activity Index (OAAI), a dimensionless number based on the number of deliveries and the number of epidurals carried out in a year.[11] However, the RCoA claims that "busy units" cannot be solely defined by crude figures, but must include other activities such as the number of regional anaesthetics provided for labour, the number of Caesarean sections and instrumental deliveries, any other procedures performed in the operating theatre, the number of critically ill obstetric patients and the number of patients seen at anaesthetic antenatal clinics.[8] Yentis and Robinson suggest using the "number of anaesthetic interventions" instead of delivery rate and the "regional anaesthesia rate" instead of rate epidural uptake, as markers of obstetric anaesthesia workload. The number of anaesthetic interventions is the sum of regional anaesthetics (spinal, epidural or CSE) done where the indication is "labour" and the number of Caesarean sections, instrumental deliveries and third stage or other procedure done in the operating theatre. The regional anaesthesia rate is defined as the number of women receiving a spinal, an epidural or a CSE for all indications divided by total number of deliveries.[12]

The methodology described above was used to collect raw data from our unit.

Labour ward operating theatre cases

During the study period there were 669 deliveries, 221 of which (33%) required theatre intervention. Most (198 cases, 90%) were lower segment Caesarean sections (LSCS): 113 were elective and 85 were emergency. Other theatre cases included suturing of birth canal tears (12 patients), manual removal of placenta (10 patients) and one instrumental delivery. LSCS rate was calculated at 29.6% of deliveries. Average number of theatre cases in 24-hours was 3.81 ± 1.55.

The commonest type of anaesthetic administered was the spinal block (152 cases, 68.8%), followed by the epidural anaesthetic (36 cases, 16.3%) and the general anaesthetic (27 patients, 12.2%). 97% of elective LSCS were done using regional anaesthesia (spinal or epidural top-up), with the remaining 3% performed under GA. For emergency LSCS, 70% were performed under regional anaesthesia, and 30% under GA. Average duration of time in theatre per case was 70.11 ± 18.86 minutes. Fisher Exact test revealed no statistically significant association between the number of cases done and the day of the week (p-value 0.773) (Figure 1). This was confirmed using time series analysis (Figure 2).

Figure 1 Total number of cases (y-axis) versus day of the week (x-axis)

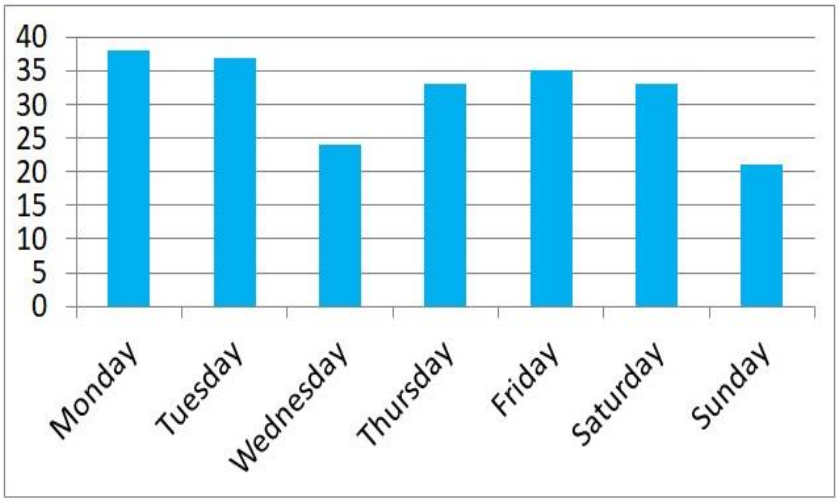
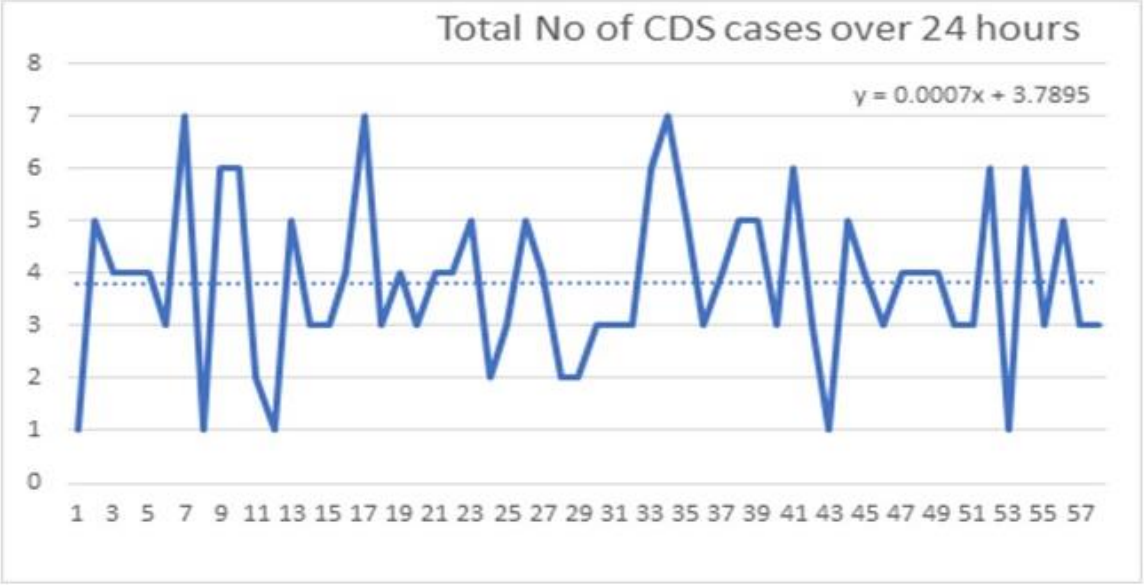


Figure 2 Total number of theatre cases per day (y-axis) versus study day (x-axis); time series analysis



Elective work overran past regular hours on 30 days (52%). Reasons for this included starting late in the morning (after 9:30am) and emergency work occupying the sole labour ward theatre (both 26% of study days), as well as elective LSCS lasting more than expected and poor scheduling of elective work (elective LSCS scheduled out-of-hours or on Sundays). There was no association between the number of epidurals done between 0800 to 1400 hours (regular hours) and elective work finishing after 1400 hours (encroaching on the on-call hours), using the Fisher Exact Test (p-value 0.656).

On two separate days, two parturients had to be transferred for urgent surgery to the main operating theatres as the labour ward theatre was occupied. In both occurrences, there were other cases being done in the labour ward operating room.

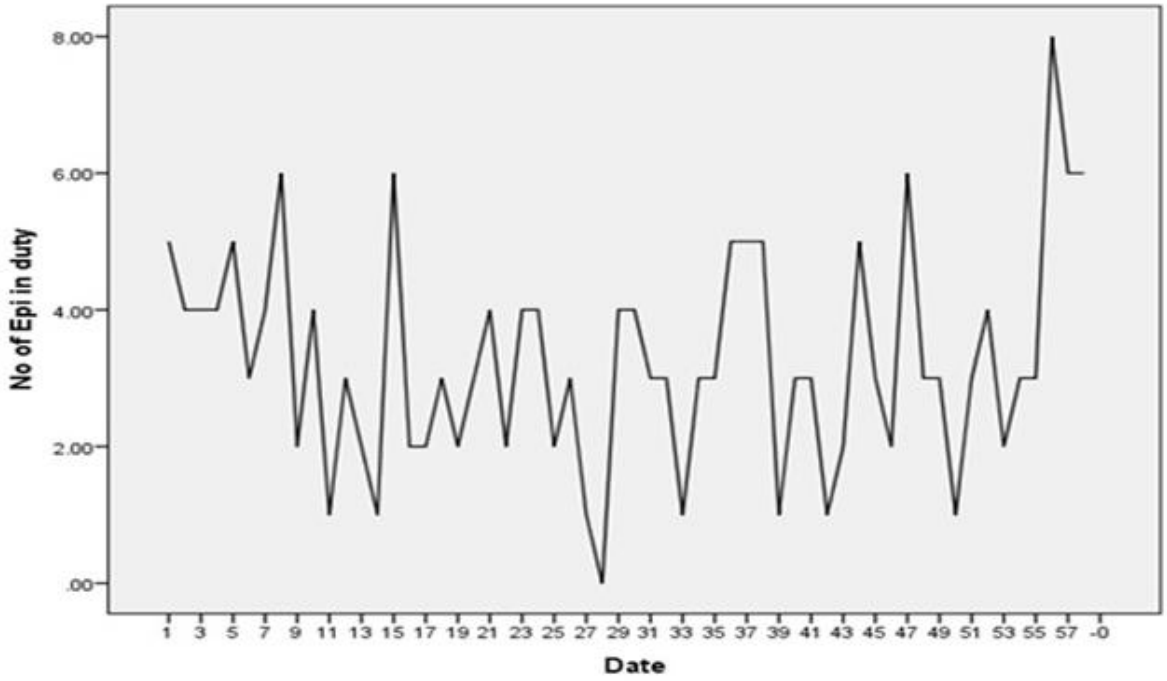
Epidural analgesia service

During the study period there were 190 labour epidurals i.e. 28.4% of total deliveries. The mean number of epidurals in a 24-hour period was 3.28 ± 1.609. The mean time in minutes between the anaesthetist being informed of the epidural request and the test dose being administered was 41 minutes (range 15 – 134 minutes). This time was over 60 minutes in 14 requested epidurals (7% of total epidurals), mainly due to the on-call anaesthetist being delayed by theatre work or due to increased technical difficulty of epidural insertion. On 7 days (12%), not all requested epidurals were done due to heavy workload.

Additional documented workload in relation to epidurals on the labour ward included documented patient reviews (*n*=38), bolus or top-up doses (*n*=37) and infusion refills (*n*=17). Most of the epidural analgesia workload was mainly carried by the non-consultant specialists (97 epidurals) and trainees (86 epidurals). One epidural blood patch for post-dural puncture headache was performed during this time.

There was no significant association between day of the week and time spent on epidurals (one-way ANOVA test, p-value 0.292) and this was confirmed using the Kruskal-Wallis test (p-value 0.203). Similarly, there was no association between the day of the week and the number of epidurals done (Fisher Exact test, p-value 0.055). This was also confirmed by time series analysis (Figure 3).

Figure 3 Total number of epidurals per day (y-axis) versus study day (x-axis); time series analysis



Anaesthetist on-call questionnaire

The 24-hour on-call obstetric anaesthesia duties were done by a non-consultant specialist on 49 days (84.5%) and by a senior trainee on 9 days (15.5%). On 18 days (31%), a junior trainee was assigned to this 24-hour duty in obstetrics.

On 90% of study days, the on-call anaesthetist felt that they were busy during the day, night or both. There was no association between how busy the on-call anaesthetist reported being and the presence of the junior trainee (Fisher Exact test, p-value 0.121) or their grade (non-consultant specialist or trainee) (Fisher Exact Test, p-value 0.701). Enough time for rest during the 24-hour shift was reported in 50% of days. Sub-group analysis revealed that the presence of the junior trainee changed the reported adequate rest rate from 45% to 61%. This allows us to infer that, although the presence of a junior trainee did not change the workload i.e. if the on-call anaesthetist reported being busy or not, it did allow the senior anaesthetist to report having better rest.

The hidden workload activities reported by the on-call anaesthetists included: patient reviews on 39 days (67%); vascular access outside of the operating theatre on 21 days (36%) and stand-by requests (for example, being present on the delivery suite in case of failed instrumental delivery) on 29 days (50%).

The on-call obstetric anaesthetist called the on-call consultant anaesthetist covering general anaesthesia on 7 days (12%) and they attended the delivery suite 3 times. Also, the on-call obstetric anaesthetist called for help from other non-consultant specialists covering the main theatres on separate 4 days (7%).

Further combined analysis

The mean duration of theatre and epidural-insertion related work was 400 ± 179 minutes per 24-hour period. This did not statistically correlate with time of the day, day of the week, a 1-in-6 pattern (most obstetrician shifts) or a

1-in-4 pattern (most midwifery shifts) using the Fisher Exact test.

A one-way ANOVA showed a significant association between the number of epidurals done and whether the anaesthetist on-call stated that they were busy during their shift (p=0.026). The suitability of the one-way ANOVA was confirmed using the Shapiro-Wilk test and Levene's test (p-value 0.450).

Discussion

Through this project, we identified six parameters that can be used to define how busy a maternity unit is. These are the delivery rate, the epidural rate, the rate of Caesarean sections, the Obstetric Anaesthesia Activity Index (OAAI), the anaesthetic interventions rate and the regional anaesthesia rate. Using these parameters only would indicate that our unit is a medium-sized delivery suite in terms of activity (Table 1).

Table 1 How busy is our obstetric unit?

	Threshold value or range identified in literature	MDH figures 2017
Delivery rate	5000	4210
Epidural rate	35%	28.4%
Caesarean rate	25%	29.5%
Obstetric Anaesthesia Activity Index (OAAI)	1.97 – 24.14	7.58
Regional anaesthesia rate	50–60%	52%
Number of anaesthetic interventions	Nil	2586.5

The fact that the time series analyses carried out were negative and that the mean duration of theatre cases and epidural insertion were not associated with day of the week, time of the day or colleagues' shift pattern demonstrates that our obstetric anaesthesia workload is unpredictable. This could be true for other units and makes appropriate staffing and of allocation of resources difficult. However, we did find a positive association between the number of epidural catheters inserted and on-call anaesthetists reporting they were busy. This correlates to the obstetric anaesthetists' clinical experience: epidural analgesia requires several steps and interventions that may stretch over a number of hours, including consenting the mother for the epidural catheter insertion, doing the procedure itself, setting up the analgesia programme, checking the quality of the block and troubleshooting any problems that may arise. These in turn vary from administering boluses and treating hypotension to re-positioning or re-inserting the epidural catheter itself.

This project demonstrated how hidden workload activities can take up considerable time: the on-call anaesthetist reported engaging in at least one such activity on most days of the study period. Any other attempts to quantify obstetric anaesthesia workload should take into account this work. Further areas of study can involve devising a unifying index that includes the delivery rate, the number of anaesthetic procedures, the number of regional anaesthetics and the hidden workload.

Defining the workload in obstetric anaesthesia can be a difficult task. Stand-alone numbers such as delivery rate and rate of epidural uptake, and the Obstetric Anaesthesia Activity Index derived from them, give a limited

indication of what really goes on as they do not take consideration the multiple activities that often go unrecorded. Using a mixed-method study design, we devised a model to collect data from several sources, including the anaesthetists finishing their on-calls in obstetrics. This in turn allowed us to compute standard figures (such as delivery rate, regional anaesthetics rate) and also quantify the hidden workload. We firmly believe this is an important component of the day-to-day work of the obstetric anaesthetist that cannot be ignored and contributes in no small way to the smooth running of and better quality of care in delivery suites.

Apart from computing the number of anaesthetic interventions carried out in our delivery suite we also recorded the duration of each procedure. Although the length of time a procedure is dependent on operator experience (in case of theatre intervention, that of the surgeons too), this is another important aspect that often goes ignored in evaluating the work intensity of a job. Furthermore, these time recordings allowed us to see how emergency work is impinging on elective cases and vice-versa, and by carrying out time-series analyses, to check if there is an association with other variables (time of day, day of the week, shift patterns).

The combined effort of literature reviews, interpretation of international guidelines and detailed data analysis as outlined above allowed us to write up several recommendations to the departmental management. These included separating the elective and emergency work and rostering different anaesthetists for each; stopping the scheduling of elective work out of regular hours; scheduling two anaesthetists fully trained in obstetric anaesthesia per 24-hour shift; and implementing a fully operational anaesthesia-led obstetric clinic for high-risk mothers.

The strengths of this project are that it ran prospectively, the study model used involved several steps of data triangulation to ensure the information retrieved was correct, and only one of the investigators inputted all data in respective spreadsheets. This was done to minimize errors and differences in data interpretation. Statistical analysis was then carried out by a professional statistician with an academic understanding of the best methods required to analyze the data and achieve our aims.

However, this study has several limitations. Primarily, data collection was not contemporaneous and depended on how well activities were recorded in the other databanks, rather than being directly observed. In the event an activity was not written up, it would have been missed by the data collectors. The on-call anaesthetists' survey was highly subjective as different people perceive being busy differently and if some anaesthetists did more on-calls than others during the study period, their answers would have skewed the results. Measuring the hidden workload depended on anaesthetists recall of events over the previous 24-hours. Also, the study period was short and even though it allowed us to better understand the level of anaesthetic activity in labour ward, the small numbers limited the statistical analysis.

Despite the study limitations, to the authors' knowledge, this is the first study that attempts to quantify obstetric anaesthesia workload not only by looking at standard data but also by identifying hidden workload, analyzing the duration of anaesthetic interventions and computing multiple statistical tests in order to establish associations between different

factors. In addition, the method used can be applied to other settings in order to distribute resources adequately and improve both working conditions and patient service and safety.

Summary Box

What is already known about this subject?

- Subjectively, obstetric anaesthetists in Malta considered the quality and safety of their work was deteriorating due to increasing workload.
- Various methods of measuring obstetric workload are reported in the literature.
- International guidance is available regarding safe staffing levels on obstetric units.

What are the new findings?

- The obstetric anaesthesia workload in Malta is defined using qualitative and quantitative methods, combining the various methods reported in the literature.
- Additional "Hidden workload" has been identified, defined and quantified.
- A preventative Safety-2 approach, as applied to obstetric anaesthesia in Malta, has allowed the development of recommendations to improve safety and quality of work.

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Presentation: Partial data was presented as an oral presentation during Euroanaesthesia 2019 in Vienna, Austria. Partial data was also presented as oral and poster presentations at the Malta Medical School Conference 2018.

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