ORIGINAL ARTICLES AND REVIEWS

The way to move beyond the numbers: the lesson learnt from the Italian Obstetric Surveillance System

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Abstract

Objective. To describe the Italian Obstetric Surveillance System (ItOSS) investigating maternal death through incident case reporting and confidential enquiries.
Methods. All maternal deaths occurred in any public and private health facility in 8 Italian regions covering 73% of national births have been notified to the ItOSS. Every incident case is confidentially reviewed to assess quality of care and establish the cause and avoidability of the death.
Findings. A total of 106 maternal deaths among 1 455 545 live births have been notified to the surveillance system in 2013-17. Haemorrhage, sepsis and hypertensive disorders of pregnancy are the leading causes of direct maternal deaths due to obstetric causes.
Conclusions. A maternal mortality surveillance system, including incidence reporting and confidential enquiries along with a retrospective analysis of administrative data sources, emerged as the best option for case ascertainment and for preventing avoidable maternal deaths.

INTRODUCTION

Maternal mortality is acknowledged as a general indicator of the overall health of a population, of the status of women in society and of the quality of health systems. The inequities of the geographical distribution of maternal mortality in the world, and the evidences that marginalized, poor and vulnerable women are at higher risk of pregnancy-related death, make maternal death an intolerable injustice and impose to take action [1]. The maternal mortality ratio (i.e. the number of maternal deaths per 100 000 live births, MMR) is the most widely used measure of maternal mortality [2]. The MMR is useful for advocacy purposes but it does not explain the real underlying reasons why particular women died and lacks information helping us identify what can be done to prevent or avoid such deaths [3]. A systematic multidisciplinary anonymous investigation of incident maternal deaths based on confidential enquiries is indeed required to understand the factors that led to the death and to put in place appropriate remedial actions [4]. Maternal mortality surveillance systems based on confidential enquiries provide the

opportunity to describe the appropriateness of obstetric care by identifying problems related to the quality of clinical practice and services organization [5]. They also support the identification of the training needs of health professionals and the definition of public health priorities in the area of maternal and newborn health. Surveillance, review and reporting are therefore a public health priority and in 2016 the World Health Organization (WHO) stated that all women deserve maternal death surveillance systems able to detect and properly investigate the causes and the critical aspects of care that can be improved [6].

At the international level approaches and methods to assess maternal mortality vary considerably [1, 7] with the UK maternal mortality surveillance system acknowledged as a gold standard worldwide [5]. The emphasis on the link between information and response to move beyond the numbers of maternal deaths is well known in the approach to maternal mortality surveillance [3, 5, 8] but it is not yet widespread.

Starting from 2008, retrospective studies based on linkage procedures of multiple administrative data

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sources conducted by the Italian National Institute of Health (ISS) repeatedly observed a 60% underestimation of the officially published Italian MMR [9, 10]. The underestimation size raised concerns among the national scientific community and the policy makers, thereby paving the way for the setup of the Italian Obstetric Surveillance System (ItOSS) in 2013, which added a prospective maternal deaths surveillance system based on confidential enquiries to the retrospective studies previously conducted to estimate the MMR. The population based prospective surveillance system aims at generating the information required to outline realistic and practical actions aimed to reduce preventable maternal severe morbidity and mortality. Continuous data collection, in depth analysis through clinical audits and confidential enquiry, as well as response by acting on findings actively promote a "no blame" culture in a country where obstetricians are often sadly influenced by a defensive medicine approach. The set up and the first three years of the prospective maternal death surveillance were funded by the Italian Ministry of Health. From 2017 a Decree of the President of the Council of the Italian Ministers attributes to the ISS the responsibility of the national coordination of the surveillance.

This paper describes the methods and the main results for the first five years of incident reporting and confidential enquiries for maternal death surveillance coordinated by the ISS in collaboration with eight Italian Regions in the framework of the ItOSS.

MATERIALS AND METHODS

The prospective surveillance system considers incident cases of maternal death from direct obstetric or indirect non obstetric causes [11] of all women who died during pregnancy or up to 42 days after the end of pregnancy (spontaneous abortion, induced abortion, ectopic pregnancy, live birth or stillbirth). All public or private health facilities with an obstetric unit and/or an intensive care unit and/or a coronary care unit and/or a stroke unit in the participating regions are included in the surveillance network, according to the assumption that all maternal deaths are intercepted by at least one of these facilities.

The eight Italian Regions included in the present study had been progressively enrolled taking into account the geographical area to which they belong and the annual number of births.

The ISS appointed a regional coordination unit (RCU) in each participating region. A reference person – a motivated medical doctor or midwife – has been selected in every facility and a multidisciplinary regional expert committee (MREC) responsible for the confidential enquiries has been put in place. Each MREC includes two obstetricians, two anesthesiologists, one midwife, one pathologist and one risk manager. Other medical specialists are involved when required. Every hospital reference person and a representative of the clinical risk management network for each facility received a residential training on the operational aspects of the surveillance system and a training package for cascade teaching to all professionals involved in the women's assistance in their obstetrics units.

Figure 1 summarizes the various steps of the ItOSS prospective surveillance. Every maternal death is notified from the facility where the death took place to the RCU, who is asked to inform the ISS central office and to verify the achievement of an internal audit in the health facility within one month of the death. The audit is facilitated by the risk manager of the hospital in collaboration with the reference person and involves all local staff who provided clinical care to the deceased woman. During the audit an anonymous form on the clinical history of the deceased woman is filled in by the participant clinicians. This form and the woman's anonymised medical records are delivered to the MREC for the confidential enquiry, which aims to assess the cause of death, the quality of care and the death avoidability. The results of the enquiry and the complete documentation of the case are finally transferred to the ISS for a central review performed with the support of the experts of the national scientific committee and of medical specialists of recognized authority in other disciplines. If the assessment of the central review differ from those of the MREC, the anonymized case is jointly discussed by the central and the regional committees in order to reach a conclusive shared evaluation. The whole system allows to describe each maternal death by cause, quality of care and avoidability. The latter are classified as: appropriate care with unavoidable outcome, improvable care with unavoidable outcome, inappropriate care with avoidable outcome. Based on the cases analysis, recommendations for clinical practice are produced and returned to health professionals. Detailed information on the organizational characteristics of the obstetric units that notify maternal deaths are also collected and analysed.

A record-linkage procedure between death registry and hospital discharge database is used to verify the completeness of the maternal deaths reporting to the prospective surveillance system. Cases retrieved in this way are considered only for the MMR estimation due to the lack of the in depth assessment.

The present study includes cases of maternal death
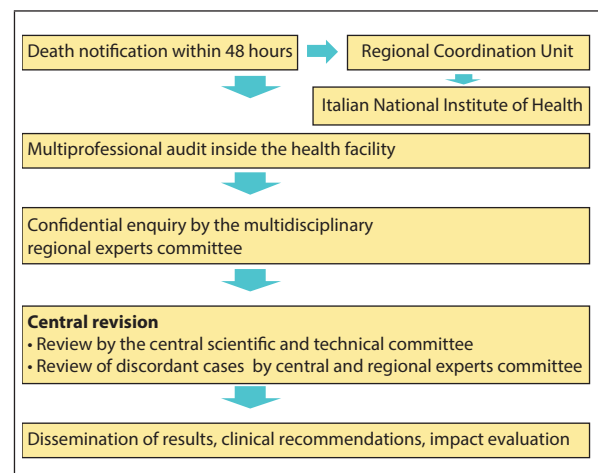
Figure 1
The prospective surveillance system flow chart.

notified or retrieved from 2013 to 2017. A descriptive analysis by sociodemographic characteristics, obstetric history and cause of death was performed. Quality of care, avoidability of the notified maternal deaths and the organizational characteristics of the obstetrics units where the women deceased were also assessed.

All analyses were performed with STATA software, version 11 (Stata Corporation, College Station, Texas, USA).

The surveillance activity was approved by the ethic committee of the INIH (Prot. PRE-C318/15, Rome 12/05/2015).

RESULTS

Maternal deaths and participating Regions

The prospective maternal mortality surveillance system started on February 1, 2013 in 6 Italian regions covering 49% of the national births and distributed throughout the country (Piedmont, Emilia-Romagna, Tuscany, Lazio, Campania, and Sicily). Lombardy and Puglia regions have joined the system in July 1, 2015 increasing its coverage to 73% of total new-borns. During the 5 years considered (2013-2017) the participant regions notified 114 cases of death. Five incidental deaths (1 car accident, 1 domestic accident, 1 homicide and 2 non-hormone-dependent neoplasms) and 3 deaths concerning non-resident migrant women were excluded from this analysis. Four more cases were identified through the record-linkage procedure. Therefore 110 direct and indirect maternal deaths among 1 455 545 new-borns [12] were counted, corresponding to a MMR of 7.56/100 000 live births (CI 95% 6.21-9.11). The 4 maternal deaths retrieved through the record-linkage were excluded from the following descriptive analysis.

Maternal sociodemographic and obstetric characteristics

Among 106 maternal deaths 50.5% women was ≥ 35 years old, 25.5% didn't have Italian citizenship with 19 women coming from low income countries (Africa, Asia or South America) and 8 women from high income countries, 7 of them from Romania. The proportion of deceased women with BMI ≥ 30 kg/m^2 was 20.8%. More than half of women (52.4%) was nulliparous, 12 maternal deaths occurred in women who conceived through artificial reproductive technologies (ART) and the multiple pregnancies were 10. Most deaths (75.5%) occurred during delivery, 30 were associated with an emergency caesarean section (CS), 17 with an urgent CS, 14 with an elective CS, 19 with a vaginal delivery and 5 with an operative vaginal delivery. Thirteen women died during pregnancy, 12 post abortion (7 miscarriages, 5 voluntary termination of pregnancy). One woman died as a consequence of an ectopic pregnancy *(Table 1)*.

Causes of death

The leading causes of the 106 direct and indirect maternal deaths were maternal sepsis (23 cases, 21.7%) and obstetric haemorrhages (22 cases, 20.8%), followed by hypertensive disorders of pregnancy (9 cases, 8.5%) and cardiovascular diseases (9 cases, 8.5%). *Table 2* de-

Table 1

Sociodemographic and obstetric characteristics of the deceased women

	Maternal deaths n = 106	
Maternal age (3 missing)	**n**	**%**
< 35 years	51	49.5
≥ 35 years	52	50.5
Citizenship		
Italian	79	74.5
Low income countries	19	17.9
High income countries	8	7.5
Educational level		
Less than high school diploma	24	22.6
High school diploma	30	28.3
University degree or higher	20	18.9
Missing	32	30.2
BMI		
< 18.5	5	4.7
18.5-24.9	27	25.5
25-29.9	13	12.3
30-34.5	7	6.6
35+	15	14.2
Missing	39	36.8
Parity (1 missing)		
Nulliparae	55	52.4
Multiparae	50	47.6
ART		
No	94	88.7
Yes	12	11.3
Multiple pregnancy		
No	96	90.6
Yes	10	9.4
Pregnancy outcome		
Abortion	12	11.3
Pregnancy	13	12.3
Delivery	80	75.5
Other pregnancy outcomes (ectopic pregnancy)	1	0.9
Mode of delivery		
Vaginal delivery	19	23.8
spontaneous	*14*	
forceps/vacuum	*5*	
Cesarean section	61	76.3
emergent	*30*	
urgent	*17*	
elective	*14*	

scribes the causes of the maternal deaths notified to the surveillance system, divided into direct (n = 58) and indirect (n = 39). Nine deaths were not classifiable.

Direct maternal deaths

Obstetric haemorrhage was responsible for 37.9% (n = 22) of the direct deaths, 2 cases occurring during the

Table 2
Causes of maternal deaths

Direct causes of maternal death	n.	%
Obstetric haemorrhage	22	37.9
uterine atony	11	
uterine rupture	2	
abruptio placentae	2	
genital lacerations	2	
early pregnancy haemorrhage	2	
uterine inversion	1	
abnormally invasive placenta	1	
unspecified haemorrhage	1	
Genital tract sepsis	11	19.0
Hypertensive disorders of pregnancy	9	15.5
Amniotic fluid embolism	6	10.3
Thromboembolism	4	6.9
Cerebral haemorrhage	2	3.4
Other causes	4	6.9
Total	**58**	
Indirect causes of maternal death	**n.**	**%**
Sepsis	9	23.1
Cardiovascular disease	9	23.1
Spontaneous haemoperitoneum	7	17.9
Neoplasm	5	12.8
Infectious diseases	3	7.7
Suicide*	3	7.7
Other causes	3	7.7
Total	**39**	

*the information on psychiatric diagnosis was insufficient to support classification as direct death [10]

first trimester and 20 during the third trimester of pregnancy or during the peripartum period. As for 13 haemorrhages, the mode of delivery was a CS while 7 cases followed a vaginal delivery. Fifteen out of 22 women died within one day from the end of pregnancy. Uterine atony was the main cause of bleeding (n = 11). After the complete review of the 22 deaths due to obstetric haemorrhage, 4 cases have been classified as unavoidable (1 described as appropriate care, 3 as improvable care) and 17 cases have been classified as avoidable with inappropriate quality of care. One case was not evaluable due to the lack of clinical documentation. The most frequent criticism reported by the professionals who assisted the women and by the auditors who assessed the haemorrhagic maternal deaths were: the lack of adequate communication between professionals, the inability to appreciate the severity of the clinical condition, the delay in diagnosis and treatment, the inappropriate care during pregnancy and the inappropriate monitoring of maternal conditions after birth. The lack of an appropriate CS indication has been reported as a criticism in 15% of the deceased women who underwent a CS.

Genital tract sepsis was responsible for 18.3% (n = 11) of the direct deaths notified to the surveillance system, with 3 cases occurring post abortion during the first trimester, 3 during the second trimester as a consequence of internal abortion leading to chorionamnionitis. The remaining 5 cases occurred during the third trimester of pregnancy, 1 after a vaginal delivery and 4 after a CS. The delay in diagnosis and treatment and the lack of adequate communication between professionals have been reported as the most frequent criticism.

Hypertensive disorders of pregnancy were responsible for 15.5% (n = 9) of the direct deaths, 4 of whom by preeclampsia, 3 eclampsia, and 2 HELLP syndrome cases. The most frequent criticism reported by the confidential enquiries was the delay in the treatment mainly related to the inappropriate use of Magnesium Sulfate and antihypertensive drugs.

Indirect maternal deaths

Sepsis caused 12 indirect maternal deaths, 5 women died due to complications of H1N1 influenza, 4 cases were attributable to septic shock (2 congenital heart diseases, 1 leukaemia and 1 liquoral derivation) and 3 cases were attributable to infectious diseases. All H1N1 infections have been treated with antiviral therapy within 48 hours from diagnosis. None of the women who died from complications of H1N1 influenza had been vaccinated during pregnancy: one died during the puerperium and all the others during pregnancy between 22 and 34 weeks of gestation. Among deaths notified as a consequence of infectious diseases, 1 woman died due to multi organ failure from malaria and 2 women have died as a consequence of a miliary tubercolosis in pregnancy.

Cardiovascular disease was responsible for 9 cases: 4 cardiomyopathies, 4 myocardial infarctions and 1 arrhythmia. One death was assessed as avoidable.

As for the 8 cases of indirect maternal mortality attributed to *spontaneous hemoperitoneum* reviewers recommended to collect an accurate medical history of the pregnant women that includes any former diagnosis of endometriosis or symptoms and signs attributable to Ehlers-Danlos syndrome or similar diseases. The assessors have also recommended a better knowledge of the pathognomonic signs of aortic dissection.

Place of death and organization of care

The majority of maternal deaths occurred in hospital (90.5%), 47 in intensive care units, 39 in hospital wards, 10 in surgery rooms and 1 in an emergency department. Six women were found dead at home, 2 died during an emergency transfer to reach a health service and one committed suicide out of the hospital. Most of maternal deaths (66.7%) occurred in birth units attending ≥ 1000 deliveries per year. *Table 3* describes the organizational characteristics of the facilities where maternal deaths have occurred.

Avoidability of maternal deaths

Out of the 106 notified maternal deaths, 90 cases have been completely reviewed at the regional and national level. For 12 cases was not possible to assess the avoidability of maternal death, in 4 cases because of incomplete medical records. Three women were found

Table 3
Organizational characteristics of the facilities where maternal deaths occurred

Structural requirements	n	%
Annual number of deliveries		
< 1000	32	33.3
1000-1999	30	31.3
≥ 2000	34	35.4
Availability of flow charts on obstetric emergencies	82	85.4
Availability of blood centre	90	93.8
Availability of radiology reports within 1 hour	92	95.8
Availability of lab reports within 1 hour	96	100.0
Availability of intensive care unit	82	85.4
Availability of a surgery room devoted to emergency CS	91	94.8

CS = caesarean section

dead at home for unknown causes and 5 were defined as *sine materia* cardiac deaths. Other 4 deaths have a pending post mortem report.

Overall, the evaluation of 90 maternal deaths through confidential enquiries assessed 34 cases as unavoidable death with appropriate care, 15 as unavoidable with improvable care and 41 as avoidable due to inappropriate care. *Figure 2* describes the avoidability of maternal deaths notified by the ItOSS participating regions compared to those reported by the United Kingdom maternal surveillance system [5].

DISCUSSION

This is the first paper that describes the results of a maternal mortality surveillance adopting incident reporting and confidential enquiries of maternal deaths in Italy as well in southern Europe. This approach provides the detailed information on woman's health status before and during pregnancy and on the circumstances of death, enabling to produce recommendations to avoid preventable deaths in the future.

In accordance with previous ItOSS findings [10], maternal age ≥ 35 years and non-Italian citizenship are more frequent among deceased women (respectively
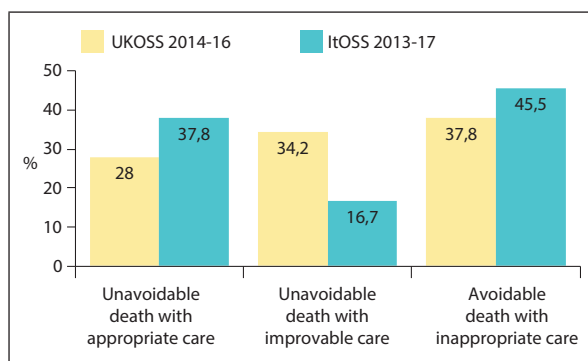
Figure 2
Avoidability of maternal deaths assessed by the UKOSS and the ItOSS maternal mortality surveillance system.

50.5% and 25.5%) than in the background population of women giving birth in the participating Regions (35% and 20%) [12].

The proportion of direct deaths in our study is higher (59.8%) compared to UK figure (43.6%) in the period 2014-2016 [5]. Therefore, an improvement in the quality of obstetric care is needed in Italy. Confidential enquiries were able to provide evidence of where the main problems in overcoming maternal mortality lie and an analysis of what can be done, highlighting the key areas requiring recommendations as well as guidelines for improving clinical outcomes.

Thanks to the information made available by the ItOSS prospective surveillance, maternal sepsis is now recognised as a public health priority ranking as the first cause of direct and indirect maternal deaths jointly in Italy. Eight of 11 genital tract sepsis were defined as avoidable and the delay in diagnosis and treatment as well as the lack of adequate communication between professionals were reported as the most frequent criticism. Considering the room for improvement highlighted by the assessment of confidential investigations, since 2017 the topic is part of an ongoing project on severe acute maternal morbidity coordinated by the ItOSS. Moreover, distance learning course on maternal sepsis has been offered to medical doctors and midwives in 2018 and Italy participated in the WHO Global Maternal Sepsis Study [13].

Since the results has highlighted the critical aspects of care associated to the high proportion of avoidable haemorrhagic maternal death (17/22), many concrete initiatives were taken from 2014 in order to disseminate results and promote a positive change. Three free distance learning courses on prevention, diagnosis and management of postpartum haemorrhage (PPH) have been offered by the ItOSS under the accreditation system of Continuous Medical Education in order to address the health professionals training needs. In 2014-2016 ItOSS implemented the first prospective population based Italian study on haemorrhagic severe acute maternal morbidity as part of the International Network Obstetric Survey System (INOSS) [14]. In 2016 the first national guideline on PPH prevention and treatment promoted by ItOSS has been published by the Italian National Guidelines System [15].

The comparison between results obtained by prospective ItOSS surveillance and retrospective record-linkage procedure, raises interesting considerations. The differences in the reported causes of direct death and in their frequency distribution is worthy of attention. Maternal sepsis ranks as the first cause of death in the ItOSS maternal mortality surveillance and fourth in the vital statistics linkage procedures [10]. Maternal death from sepsis is increasing in countries with advanced healthcare systems [16] and vital statistics linkage procedures often misclassify this diagnosis [17]. Therefore, the ability of prospective surveillance to promptly identify the cases of sepsis is particularly valuable. Obstetric haemorrhage ranks first in the vital statistics linkage procedures [10] and second and in the prospective ItOSS surveillance probably due to the recent increase of maternal sepsis incidence and due to the reduction of the

haemorrhagic deaths in the country [10]. Among indirect maternal deaths, cardiovascular diseases match as the first cause in the results of both of the methods [10]. ItOSS is planning a collaboration with the cardiologists to promote the diagnostic capacity of clinicians who assist pregnant and postpartum women and to facilitate a multidisciplinary management of these complex clinical conditions which, also due to the advanced maternal age at birth, occur more frequently to the observation of health professionals.

Deaths caused by influenza H1N1 and deaths occurred among women who underwent ART treatments are detected only by prospective maternal mortality surveillance. In the face of national and international recommendation to vaccinate pregnant women during seasonal influenza epidemic [18, 19], in Italy coverage is still very low. It is urgent to design and implement a proper information campaign to inform pregnant women that during the period of seasonal influenza epidemic, is highly recommended vaccination, frequent and thorough hand-washing and timely consultation of a doctor in case of fever and worsening dyspnoea [19, 20].

The specific MMR for neoplasm estimated retrospectively by ItOSS is 0.8 maternal deaths per 100 000 live births [10] and the prospective surveillance identified 5 cases of pregnancy associated malignancies during the years 2013-2017 in the participating regions *(Table 3)*. Cancers and pregnancy are two events increasingly associated probably due to the higher maternal age at conception and due to improved antenatal diagnosis opportunities. Reported incidence of pregnancies-associated cancers is around 1/1000 in the literature [21], while a national figure is still lacking in Italy [22]. In 2019 the ItOSS promoted an ongoing study with the collaboration of 18 Cancers Registries covering 25% of the national population, and the Italian Society of Obstetrics and Gynaecology (SIGO). Objective of the study is to estimate through record linkage procedures, the incidence of pregnancies and their outcomes in a wide cohort of women of reproductive age with neoplasm diagnosis. The results of the project will describe the occurrence of cancers during pregnancy and investigate the relation between disease stadium and maternal and foetal outcomes.

Obesity seems to play a role in the chain of events that can lead to serious maternal morbidity and mortality. The proportion of obese women is respectively 20% among the ItOSS notified maternal deaths and 7% among women of reproductive age resident in the same Italian Regions during the exact study period (www.epicentro.iss.it/Passi/). This finding is in line with what has been found by the UK maternal mortality surveillance system [23] confirming the urgency of supporting women's ability to undertake pregnancy with an appropriate body weight.

Among the 12 maternal deaths occurred in women undergoing ART, 4 women were aged > 42 years and 7 had a BMI > 30, characteristics likely related to worst obstetric outcomes. Despite live births rates after ART treatments in UK are quite similar to those observed in Italy [23] the proportion of maternal deaths in this specific population is lower in UK (3.1%) [24] com-

pared to that found in the 8 Italian participating regions (11.3%). These results suggest that more attention should be payed to the selection of women accessing to ART treatment in the Italian National Health Service in order to make ART a safe choice for the women. In this respect, women older than 42 years or with BMI > 30 cannot access to high level NHS ART treatments in England, as recommended by NICE [25].

Prospective maternal mortality surveillance through incident reporting and confidential enquiries confirms itself as a better approach than vital statistic system to identify the current incidence of the specific causes of maternal deaths and current priorities for action. On the other hand, due to the low incidence of maternal deaths in Italy, the large retrospective time span of vital statistics analysis provides a sufficient number of cases to take into account MMR differences by geographical area and by women's characteristics [9, 10]. The MMR estimated through the prospective surveillance (7.56/100 000 live births) is not significantly lower (p value = 0.08) than the MMR of 9.18/100 000 live births estimated through the record-linkage procedures in seven years, from 2006 to 2012 [10].

To date, the main limits of the ItOSS surveillance are the subnational coverage and its recent start, which limits the robustness of the data analysis. Moreover, the delayed availability of post mortem reports in case of judicial authority involvement impairs the possibility of a timely assessment of all cases. Short term perspectives include the extension of the surveillance to the whole country, in 2019 a 91% coverage of national newborn being reached. A pilot project of perinatal mortality surveillance [26], further prospective population-based studies on severe acute maternal morbidity, the continuous training of health professionals in the critical areas that arise from the surveillance and the provision of recommendations for clinical practice are ongoing activities coordinated by ItOSS in the field of maternal and newborn health.

CONCLUSION

A dual approach to investigate and monitor maternal mortality including vital statistics analysis and prospective surveillance relaying on incident reporting and confidential enquiries is, in our opinion, the best option for case ascertainment. Learning lessons and acting on the results is the core of using an active surveillance approach aimed at saving more women's lives and at improving quality of maternity service. Confirming the validity of this dual approach the last Euro Peristat Report [27] described the ItOSS as one of the 7 enhanced maternal mortality surveillance systems active in Europe.

Contribution to authorship

SD, designed the study and provided conceptual guidance, provided clinical input to the data analysis and to the results interpretation and contributed substantially to the writing of the manuscript, coordinated the regional working groups and the facilities participating in the surveillance, performed the training of the health professionals involved in the surveillance, participated in the national review of the maternal mortality

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