S1 Appendix. Regular quality assurance process of the Shanghai CRVS system

Death certificates can be issued from three sources in Shanghai. Hospital clinicians issue death certificates for hospital deaths (69% of all deaths) and community health physicians (public health doctors) at CHCs complete death certificates for home deaths (30% of all deaths). The certificates issued by CHCs and hospital physicians both conform to the World Health Organization (WHO) standard, which contains basic information including name, sex, birthdate, death date etc., as well Part I and Part II, that include death sequence and contributory causes of death. Part I presents the death sequence, includes diseases or conditions that formulate the sequence of events leading directly to death. Part II includes the other significant conditions contributing to death (Fig SS1). The district CDC doctors and CHC physicians code the UCOD and all CODs in the death sequences according to ICD-10. Both CDC and CHC have staff working as coders who receive regular training on COD assignment and ICD-10 coding. External causes or “unnatural” deaths (1% of all deaths) are certified by Public Health Office (PSO) and the certificates are issued by the coroner affiliated with the PSO. Death registration information is exchanged between the district level PSO and CDC every month. Following certification by the coroner, the quality control and audit process is the same as for hospital or home deaths.

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The Shanghai CRVS system has stringent data quality checking procedures that are performed by doctors at both Shanghai CDC and the district CDCs to check for and correct implausible/ impossible causes of death, as follows:

1. Public health doctors at district CDC convert the sequence of events leading to death into standard ICD-10 cause code and select the original underlying cause of death (UCOD) text on the death certificate according to the coding rules. This is referred to as the "original UCOD".
2. If this UCOD is not a clear antecedent disease that could give rise to the sequence of events leading to death, or if anything is unclear, doctors at district CDC communicate with the hospital where the death occurred to review the medical record and/or for CHC doctors to contact the family of the deceased for more information (a form of unstructured verbal autopsy). After this procedure, the district CDC doctors correct the UCOD.
3. Doctors at Shanghai CDC check all UCODs and identify the impossible/implausible UCODs and provide feedback to district level CDCs for second-round correction by the district CDC doctors. If any inaccuracies persist, the medical record tracing and family investigation is conducted again. This whole quality control process is performed each month.

Using this three-step procedure, the Shanghai CDC gathers electronic death information from each district CDC and performs the data audit. In addition, every six months there is a further extensive quality check of all collected death data organized by Shanghai CDC. All the district CDC doctors assemble in Shanghai CDC, with death certificates issued from their districts. District doctors will review the certificates from other district(s) (called as mutual quality control) and provide suggestions made for modification. The resulting UCODs are stored in the Shanghai routine death registration database as final UCODs; This is referred as "routine UCOD".

居民死亡医学证明书

表号：卫统 26 表
制表机关：卫生部. 公安部
批准机关：国家统计局
批准文号：国统制[2010]5 号

省 市 区(县) 街道(乡) 2016 No. 0000000

第二联 由公安部门收集交卫生部门

死者姓名 name		性别 sex	民族 nation	身份证号码 ID number			
婚姻状况 marital status				文化程度 educational attainment			
生前主要职业及就业状况 occupation				是否婴幼儿，学龄前儿童 preschooler: yes or no		是否弱智 weak intelligence: yes or no	
出生日期 birth date		死亡时间 death date		实足年龄 age	死亡地点 death place		
生前工作单位 name of work unit					生前是否处于妊娠期或妊娠终止后 42 天内 gestation period or within 42 days after termination of pregnancy: yes or no		
户籍地址 address of pernament residence						可以联系的家属姓名、住址或电话 name and address or phone numbers of family members for further contact	
现居住地址 address of current residence							
死亡原因：填写导致死亡的疾病、损伤或并发症，每行只填一个疾病。不能仅填临死的情况，如心脏或呼吸抑制、休克、心衰等。 COD							发病日期 onset date
I. (a) 直接死亡原因（导致死亡的最后的疾病和情况） (b) (c) (d) 任何引起上述原因的疾病情况，如有则按顺序列出（最后一行为导致死亡的最早的疾病或损伤）	a. （直接死亡原因） COD-a (direct cause of death)						
	b. （引起 a 的疾病或情况） COD-b (the disease or conditions to cause a)						
	c. （引起 b 的疾病或情况） COD-c (the disease or conditions to cause b)						
	d. （引起 c 的疾病或情况） COD-d (the disease or conditions to cause c)						
II. 促进死亡，但与导致死亡的疾病或情况无关的其它重要情况 other diseases 1. 2. 3.							
上述疾病的最高诊断医院 The highest level hospital in diagnosing the above diseases				填报医疗单位 The hospital to report the above information			
上述疾病的最高诊断依据 The highest level of diagnostic evidence							
住院号 hospital ID	医师签名 signature of doctors		填报日期 report date 年 year 月 month 日 date		单位盖章 stamp of hospitals		
以下由死因编码人员填写 根本死亡原因 ICD 编码：underlying COD				规则：rules for coding			

Fig SS1 The death certificate for hospitals and CHCs in Shanghai

S2 Appendix. Medical Data Audit Form(MDAF) form for Shanghai

Study ID [ ]

Medical Record/Hospital No [ ]

Shanghai Study physician Review form (MEDICAL DATA AND AUDIT FORM)

Section 1: Background Information

Name of Deceased	
Date of Birth	
Date of death	
Age of the deceased at death	
Sex of the deceased	
Department/Ward	Medicine Surgical Neonatal / Neonatal ICU Paediatric Gynaecology / Obstetrics Cardiology / CCU Orthopaedics Other (Please specify)
Location where the form was filled in	Name of the hospital
ID number of the deceased	
Phone number of the family members of the deceased	
Residence of the deceased	

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SECTION 2: Study Physician review

2.1 Death certificate as determined by study Physician

Causes of death from medical audit		Interval from onset to death	ICD10 codes					
1a Immediate Cause						.		
1b Antecedent Cause						.		
1c Antecedent Cause						.		
1d Underlying Cause								
II Other significant conditions contributing						.		

2.2 Study physician cause of death for for misclassification matrix

ICD10 Code for UCOD	**Diagnosis for misclassification matrix (Shanghai text)**	**Misclassification Code (Shanghai code)**

2.3 Final underlying cause of death selected by the coder after completing the coding process

ICD10 Code for FUCOD	**Final Underlying Cause of Death**

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Section 3. Hospital Diagnoses

3.1 Hospital Death Certificate

4.1 Causes of death from death certificate		Interval from onset to death	ICD10 codes					
1a Immediate Cause						.		
1b Antecedent Cause						.		
1c Antecedent Cause						.		
1d.Underlying Cause								
II Other significant conditions contributing						.		

3.2 Hospital diagnosis for misclassification matrix

ICD10 Code for UCOD	**Diagnosis for misclassification matrix (Shanghai text)**	**Misclassification Code (Shanghai code)**

3.3 Underlying cause of death selected at the District CDC

ICD10 Code	**Underlying cause of death from District CDC data base**	

Section 4. Evaluation of quality of medical record and hospital death certification

4.1	Was it necessary to change the underlying cause of death (UCOD)?	Yes No → go to 4.6
4.2	The difference of ICD coding for UCOD between 2.2 and 3.2 is?	A. only the coding after the decimal point are different B. totally different
4.3	Did changes in diagnosis on the DC lead to a change in UCOD?	Yes → go to 4.6 No
4.4	Accuracy of the death certificate Did changes to the sequence of causes lead to a change in UCOD?	Go to 4.6

4.5	**Compatibility**	**YES**	**NO**
	Whether the FUCOD code selected by the coder in 2.3 is compatible with the UCOD code selected at district CDC (3.3)?		

4.6	Ranking of medical audit death certificate	**GS 1**	
		GS 2	
		GS 3	
		GS 4	
		Other	

Name of the study physician