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The recording of fatal work-related injuries in information systems in Brazil

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Abstract *This study aims to identify information systems having fatal work-related (ATF) data in Brazil, describing their characteristics, flows and barriers to information quality. Using a documental research approach, we found: the Mortality Information System (SIM), the Hospital Admission Register from the Unified Health System (SIH-SUS), the Notifiable Diseases Information System (SINAN) and the Violence and Injuries Surveillance Program (VIVA) from the Health Ministry; the Work-related Injuries Reporting System (SISCAT) of the Ministry of Social Insurance; and the Annual Report of Social Information (RAIS), Ministry of Labour and Employment. A lack of key common variables limits the construction of a single database composed by all ATF recorded cases. From several barriers identified, the most relevant for data quality was the lack of work-relatedness recognition and recording, a task performed by the health team.*

Key words *Fatal work-related injuries, Information systems, Brazil*

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Introduction

Fatal work-related injuries (ATF) have a significant impact on mortality rates, are preventable, and considered an important public health problem. They therefore, require precise recording and related information needs to be employed for planning and management purposes. Every year, approximately two million workers die in work-related injuries globally[1], while in 2012, the corresponding mortality rate in Brazil was estimated as 7/100,000 workers[2]. These injuries are monitored in several information systems with data based on three conceptual dimensions: 1) the type of injury, characterised as "lesions, poisoning and other consequences of external causes", which corresponds to the International Classification of Diseases, 10th Review (ICD-10) codes of Chapter XIX (S and T), replaced by Chapter XX (V, X and Y) named External Causes; 2) a causal relationship with work (typical) or when commuting; and 3) the injury outcome that could be death.

The information systems of interest for ATF identification are those from the social insurance, labour and employment, and health institutions[3]. Information systems from social insurance institutions are the most commonly used for monitoring and research of work-related injuries, because of the availability of distinct occupational compensation benefits. In countries where social insurance is universal under the state responsibility or have wide coverage, data from their information systems may represent all workers[3,4]. However, in countries in which a large number of workers are not covered by social insurance, information from these systems is limited. Information systems from labour and employment protection institutions may contain ATF data records[5,6]. National health information systems are commonly universal and may have data that can be used to estimates vital statistics, such as mortality rates. Death certificate are the most well-known source of information, which may contain specific boxes to gather data on the work-relatedness of the cause of death. Other common ATF data sources are repeated surveys conducted on national samples, of complementary nature, which can be used to assess validity of compulsory employers-based information, proven to be commonly unreliable[7].

In Brazil, several information systems include ATF records, which quality and coverage have been improving, particularly in recent decades[8], in spite of their limited use in research or surveillance. Findings from a literature review shown that the availability of ATF data is not widely known, causing negligence respect to data quality and low recording levels[9]. In this study, we intend to improve the knowledge about the available information systems that record ATF data in Brazil, identifying and describing these systems, their quality and coverage limits.

Methods

This is a documentary study carried out with texts about information systems, managed by Brazilian public institutions, in which data about work injuries are recorded. First, a list of institutions of interest was created, comprised by the National Social Insurance Institute, the Ministry of Social Security, the Ministry of Labour and Employment, the Ministry of Health, and the Ministry of Justice. To each of them, official websites were searched for access to information systems, manuals, guides, databases and requirements. We also consulted their data collection instruments, information flows and tools for tabulation and graphic interfaces.

The analytical categories were: the institution; the reference population – people whose data are entitled for the information system; sources – instruments used to input data into the information systems; type of access – public or restricted; formats – types of files available; and time covered – in years. Each source was searched for data useful to identify ATF: 1) ICD code; 2) injury work-relatedness; 3) death as outcome. To facilitate our analysis these systems were classified as: a) non-specific to work injuries; and b) specific or exclusive to work-related injuries. The analysis was based on the organization of information into tables and the creation of a flowchart showing common steps starting with the injury occurrence and ending with the ATF recording in the information systems. To each stage, potential filters and barriers to case identification and recording were identified and described.

The project was registered on the National Research Ethics System, Plataforma Brasil, and approved by the Internal Review Board of the Institute of Collective Health, Federal University of Bahia.

Results and Discussion

Information systems that record ATF data

In Brazil, there are eight information systems that contain ATF data. Five were non-specific for work-related injuries: 1) the Mortality Information System (SIM); 2) the Hospital Medical Records of the Unified Health System (SIH-SUS); 3) two subsystems of the compulsory Notifiable Diseases Information System (SINAN), for Exogenous Poisoning and the other for Violence and Injuries Surveillance Program (VIVA), all managed by the Ministry of Health; 4) under the Ministry of Labour and Employment, the Annual Report on Social Information (RAIS) contains deaths data from registered workers when active (Table 1). Three systems were specific and restricted to work-related injuries: 1) two were from SINAN, Ministry of Health, the Severe Work Injuries and Work Injuries with Potential Exposure to Biological Materials; and 2) from the Social Security Ministry, the Work Injuries Communication System (Siscat) (Table 2). The steps where information is generated and their corresponding flows are presented in Figure 1.

Information systems non-specific to work-related injuries

The Mortality Information System (SIM)

The SIM exclusively provides data about deaths and compose, with other information systems, the country´s vital statistics database from death certificates (DO). These documents enable the identification of ATF by checking ICD codes for the underlying and associated causes of deaths. For external causes of deaths, specifically, data on the "probable circumstances" are required to be registered in the following fields: type – whether death was related to an accident (injuries), suicide, homicide or other; and whether it was work-related (yes/no/unknown) (Table 1). The universal nature of SIM is its main advantage, because all workers regardless their type of job contract are covered, even those having informal jobs, the military and public officers, enabling comparisons of AT mortality estimates across countries. Other SIM advantage is to have data on occupation coded by the Brazilian Occupation Classification (CBO), based on the International Standard Classification of Occupations (ISCO). Unfortunately, trade or type of position in the labour force, whether formal or informal, is not available.

Over the last decade, SIM coverage has been increasing, varying from 87.0% in 2000 to 96.1% in 2011[10], classified as of intermediary quality by the World Health Organization[11]. The SIM recording quality is also improving, as shown by the decreasing of deaths registered with ill-defined causes, falling from 7.2% in 2009 to 6.7% in 2011[10]. The introduction of a specific section to register data about non-natural deaths (external causes) on death certificates in 1999, with a field for data on work-relatedness, represented a considerable advance for ATF recording. However, this field completion is low, 20% average between 2000 and 2010[12]. A field for work-relatedness was also incorporated into the death certificates in the United States[13,14], a strategy that could be used worldwide, especially in countries with large ATF underreporting.

Hospital Medical Records of the Unified Health System (SIH-SUS)

The SIH/SUS is other non-specific information system that takes records of ATFs[15,16]. Although limited to SUS hospital care, excluding private ones, the SIH-SUS comprises 70% of the country total hospital admissions[17,18]. Its data source is a required document, for funding/reimbursement purposes, named Hospital Admittance Authorization (AIH), in which are registered: 1) ICD codes of the main and secondary diagnosis; 2) the work-relatedness and type (whether it occurred "in the workplace/on duty" or "commuting"); and 3) death occurred at the hospital. In 2001, these fields were updated[15] (Table 1) and, of interest to workers' health, these other ones were added: 1) occupation coded with the Summarized Brazilian Occupations Classification (CBOR), industries, which are coded with the Industry National Classification (CNAE), the firm registration number at the National Register of Juridical Person (CNPJ), and the "social insurance coverage status" (employee, employer, self-employed, unemployed, retired and "uninsured")[16], which instead means labour market status.

The SIH-SUS is an important additional source of ATF data, although not always fatal work injuries require hospital or emergency care. Its coverage and accuracy are presumable high because of its own nature, although work-relatedness may be missed or misreported in association with vested interests[19]. A study about the quality of SIH/SUS external cause records showed a moderate level of agreement between recorded and gold-standard diagnoses[20], but it

Table 1. Features of information systems non-specific to work-related injuries which include data about fatal work injuries (ATFs), Brazil, 2015.

Institution responsible	Information system	Target population	Source	Fields of interest for the identification of ATFs			Type of access	Formats	Time period
				ICD codes	RRelationship with work	Outcome			
Ministry of Health	**SIM**	Total population	Death Certificate (DO)	<causabas> Underlying and associated cause of death	<acidtrab> Work Injury1-Yes; 2-No; 9-Unknown.	-------	Public / DATASUS	DBC	1979 to 2013
	SIH/SUS	Population admitted to SUS or contracted hospitals	Hospital Medical Records (AIH)	<diag_pri> Main Diagnosis Code <diag_sec> Secondary Diagnosis Code	<car_int> Nature of hospitalisation 1-Elective; 2-Emergency; 3-Injury in workplaces or on duty; 4-Work-related injury when commuting; 5- Other types of vehicle related injury; 6- Other type of poisoning injury	<apres> Patient status 1-Discharge; 2-Remain; 3-Transfer; 4-Death; 5-Other reasons; 6-Birth procedure.	Public / DATASUS	DBC, CSV	1992 to 2015
	SINAN – Exogenous poisoning	Exogenous poisoning cases	Exogenous poisoning investigation sheet	-------	<doenca_tra> Exposure related to work/ occupation 1-Yes; 2-No; 9-Unknown	<evolucao> Case evolution 1-Cure without sequelae; 2-Cure with sequelae; 3-Death by exogenous poisoning; 4-Other cause of death; 5-Lost follow-up; 9-Unknown.	Public / MS and CCVISAT	MS: CSV CCVISAT: SAS, XLS and DBF	MS: 2007 to 2015 CCVISAT: 2006 to 2012
	VIVA – component VIVA/ SINAN	Cases of violence	INAN form specific to the investigation of domestic, sexual and other forms of violence	-------	<rel_trab> Work-related violence 1-Yes; 2-No; 9-Unknown	<evolucao> Case status 1- Discharged; 2-Evasion/ Escape; 3-Death by Violence; 4-Other cause of death; 9-Unknown.	Public / DATASUS, completion of required form	CSV	2009 to 2011

it continues

Table 1. Features of information systems non-specific to work-related injuries which include data about fatal work injuries (ATFs), Brazil, 2015.

Institution responsible	Information system	Target population	Source	Fields of interest for the identification of ATFs			Type of access	Formats	Time period
				Códigos da CID	Relationship with work	Outcome			
Ministry of Labour and Employment (MTE)	**RAIS**	Population of formally registered workers, with Employment Record Card	RAIS Reporting/ CAGED Reporting	------	------	<caus_afast> Reason for job contract ending 60-Death; 62 - Death due to work-related injury which occurs in the workplace or on duty; 63-Work-related death due to injury when commuting; 64-Death due to professional illness; and Others	Password protected / MTE requirement	CSV, XLS, PDF, RTF	1985 to 2013

ICD: International Classification of Diseases; RAIS: Annual Report on Social Information; SIM: Mortality Information System; SIH/SUS: Hospital Medical Records of the Unified Health System; SINAN: Notifiable Diseases Information System; VIVA: Violence and Accidents Surveillance Programme; DATASUS: Information Technology Department of the Unified Health System; MS: Ministry of Health; CCVISAT: Collaborating Centre for the Surveillance of Work-Related Diseases and Injuries, Institute of Collective Health, Federal University of Bahia.

did not address work-related injuries. Hospital records have been used and recommended for ATF surveillance in the United States[21] and Finland, where national hospital admissions databases are available[22].

Notifiable Diseases Information System (SINAN)

The SINAN comprises several information subsystems concerning compulsory notifiable diseases and injuries, some of them having useful data for ATF identification. For instance, in the two subsystems for Exogenous Poisoning and for Violence there is in each one a box to be filled with data on work-relatedness (yes/no/unknown) and two other fields contain data about death as the outcome (Table 1). Similarly, these data are also recorded in the Accidental Tetanus, Venomous and Poisonous Animal-Related Injuries and Viral Hepatitis subsystems. A major advantage of these SINAN subsystems is having coded "occupation" although not always recorded.

Annual Report on Social Information (RAIS)

The Ministry of Labour and Employment manages the RAIS information system, which monthly receives data compulsorily provided by firms to the Employed and Unemployed General Register (CAGED). To each active worker, employment status and every change in job contracts such as wages and occupation, any maternity or sick leaves, and work-related injuries, either "typical" or "when commuting", are recorded and reported to CAGED. This database access is granted upon request (Table 1). We did not find ATF studies based on the RAIS or information about its quality or coverage, but certainly it can be used as an additional source of information in research or surveillance. It is worth noticing that the RAIS is limited to formal registered workers, approximately 51% of the employed Brazilian population in 2010[23].

Information Systems specific to work-related injuries

SINAN - Subsystems for Severe Work Injuries and for those Involving Exposure to Biological Material

The Severe Work Injuries subsystem of SINAN comprises data from compulsory notification of fatal or non-fatal cases, when involving mutilations or hospitalizations among adults, and regardless injury severity when victims are

children or adolescents. The other SINAN subsystem is for Work Injuries involving Potential Exposure to Biological Materials. In both subsystems, deaths are recorded in two fields of the source form (Table 2), which also has data on occupation, industry, and the firm or employer name and the CNPJ number. Unfortunately, almost ten years since its inception in 2007, these subsystems remain under implementation with high underreporting. Up to 2011, 71.7%[24] of municipalities did not report any work-related injury, despite its increasing coverage[25]. It can be a result of the initial strategy to limit notifications from the sentinel units' network. This is a system composed by health services especially prepared to input data into the information system which was modified in 2014, when every health care facility became entitled to notify occupational injuries[26]. The access to these databases is upon requirement to the Ministry of Health.

Injuries Communication Information System - SISCAT

Siscat is an information system exclusive for work-related diseases and injuries, the most utilized to estimate national epidemiological indicators. Its feed source is the Work Injury Communication (CAT), and it is not limited to injuries covering work-related illnesses as well. CAT is compulsory issued by firms, in addition to health services or workers themselves, regardless the injury/disease severity or work disability. Besides identification of the worker and firm, it contains data on type of injury (1-typical work-related injury/ 2-occupational illness / 3-work injury when commuting); the ICD code; and whether death had occurred (1-yes/ 2-no). The Statistical Yearbook of Labour Injuries (AEAT), available in the National Social Insurance Institute website, provides some summarized SISCAT data, while an infologo allows drawing tables, although limited to a few indicators and descriptors (Table 2). Other information system under the National Social Insurance Institute is the Compensation Benefits Information System (SUIBE), not limited to occupational-related injuries and diseases. Based on records of compensation benefits granted in cases of work disability due to sickness, pensions or retirement, these data are also presented in the AEAT. For ATF, however, the SUIBE is limited because benefits are only granted to eligible relatives. Although SISCAT records have good quality, underreporting has been found, particularly for cases having work disability for 15 or more days, time required for compensation benefits eligibility[27].

Other information systems

Because of their violent nature, ATF are also registered by public security institutions such as the National System of Public Security and Criminal Justice Statistics (SINESPJC) and the National Information System for Public Security, Prisons and Drugs (SINESP). Several data sources fed the SINESPJC, such as the Police Occurrence Report (BO) compulsory issued by the police authority to each claimed violent event. Therefore, each time a death related to external cause occurs the local police department might be immediately informed. Following, a registration document, BO, and an authorization to the technical police are issued. This last one permit to carry out a local investigation, the collection of proofs and the body removal to the closer forensic legal medicine institute (IML), in which the needed exams are conducted to release a coroner report and the death certificate[28]. When death occurs during the transportation to the health care unit, or afterward when under hospital treatment, regardless its duration, procedures are similar: the district security police department might be informed, which issues a BO, the authorization for the technical police and the following already described steps, accordingly. The SINESP is computerized and decentralized, represents an advance to SINESPJC, and it is aimed at to create a single database network to ensure efficient interoperability between security and defence institutions[29]. However, the SINESP is not fully implemented yet and data are not available. Throughout the country, IMLs[30] have distinct information systems which may also register forensic and BO data that enable ATF identification. These data can be used in research or surveillance[31].

In sum, there are multiple ATF records in several information systems available, similarly to other countries. This is a consequence of distinct interests and responsibilities of institutions that need to create and keep ATF records. Originally created for administrative purpose, such as those under the Ministries of Labour and Employment and Social Security, they have been utilised for monitoring and even for prevention. However, they are limited to formal workers or those having work injuries insurance, leaving the unregistered out of the occupational health statistics. In addition, multiple databases without a common individual key variable require complex procedures to be integrated in a single one. Although some databases have limited coverage and poor recording quality, they enable missing data imputation or misclassification correction.

Table 2. Characteristics of information systems specific to work-related injuries, Brazil, 2015.

Institution responsible	Information system	Covered population	Source	Fields of interest for the identification of ATFs		Type of access	Formats	Time period
				ICD codes	Outcome			
Ministry of Health	**SINAN – Severe Work Injury**	Economic Active Occupied Population (PEAO)	Severe work injuries investigation form	-------	<evolucao> Outcome 1-Cure; 2-Temporary incapacity; 3-Partial incapacity; 4-Permanent, total incapacity; 5-Death due to severe work accident; 6-Other cause of death; 7-Other; 9-Unknown.	Public / CCVISAT	SAS, XLS, DBF	2006 to 2012
	SINAN – Work Injury involving Exposure to Biological Material	Health workers	Investigation form for work injuries involving exposure to biological material	-------	<evolucao> Outcome 1-Discharged with serological conversion; 2- Discharged without serological conversion; 3-Patient discharged - negative serological source; 4-Abandoned treatment; 5-Death due to injury involving exposure to biological material; 6= Other cause of death; 9=Unknown.	Public / CCVISAT	SAS, XLS, DBF	2006 to 2012
Ministry of Social Security	**SISCAT**	Population covered by the work-related injuries and diseases insurance	Work injury communication form (CAT)	Type:[1] 1-Work-related injury in workplace or on duty; 2-Work-related illness; 3-Work-related injury when commuting. ICD	Did death occur?[1] 1-Yes; 2-No	Restricted / DATAPREV, Statistical Yearbook of Labour Accidents, (AEAT[2])	CSV, XLS, PDF, XML, HTML, RTF	1999 to 2013

ICD: International Classification of Diseases; SINAN: Notifiable Diseases Information System; SISCAT: Work Injuries Communication System; DATAPREV:Social Security Information Technology Company; CCVISAT: Collaborating Centre for the Surveillance of Work-Related Diseases and Injuries, Institute of Collective Health, Federal University of Bahia.

[1] Code for this field not available; [2] The AEAT presents CAT data and information about compensation benefits granted by the National Social Insurance Institute (INSS), and recorded in the Unified Benefits Information System (SUIBE).

Also, overlap of responsibilities across multiple institutions may pose difficulties to set up an efficient and effective coordination and integration of practices, a still major challenge for workers' health policies[32]. The recent creation of a single information system under the national social insurance, the E-social, integrating life-long workers' data as for occupation, trade, maternity or sick leaves among others, is an optimistic perspective for both surveillance and research[33]. The SUS is creating the E-saude, alike the E-social, rendering data for the much needed interdisciplinary and intersectorial approaches[34].

Barriers to ATF recording

The Figure 1 aims at to provide a better understanding of the connections between the several information systems involved in ATF recording, showing their steps, flows and potential barriers or filters that presumably limit data coverage and quality. The flow chart starts with the work-related injury death which may occur under the following circumstances: 1) at the scene, in the workplace or outdoors, when performing a job task – an immediate police communication to the Public Safety Authority is required, and a recording document, the BO is issued, in addition to a legal request to remove the corpse by the Technical Police. An investigation about the circumstances is performed by hearing witnesses at the location where materials are collected for evidence. The corpse is taken to the closest IML for necropsy and laboratory exams when needed. Finally, a coroner report (LC) and death certificates (DO) are released, containing information that may be useful to establish the injury work-relatedness; 2) death occurs during the transport or under treatment in emergency or hospital care – the institution in charge informs the Public Safety Authority, and all steps described previously might be followed, and BO, LC and DO are also released. If the health care was provided by the SUS, the ATF is recorded in the SIH/SUS and in several SINAN subsystems where applicable; 3) death occurs in remote, distant places, where there is no police office, IML or health care – procedures change according to the context but in every case all legal documents, BO, LC and DO might be issued.

Independently of the death circumstance of occurrence, records of ATF on SINAN will be made whether health care units are available with skilled teams, given that universality of compulsory notification is recent. In addition, for any case of registered formal worker, the National Social Insurance Institute (INSS) records ATF in the SISCAT when CAT is issued and, in the SUIBE when relatives are granted with indemnities or pensions (Figure 1). Records on both SISCAT and SUIBE will depend: on the victim's family will and awareness about their rights to receive these benefits; and, on the knowledge about the importance of ATF recording by the health care staff or employers. Indeed, employers need to inform about ATF in the monthly forms of CAGED and, consequently, into the RAIS (Figure 1).

Barriers and filters in the information flows are common and described in other countries[35,36]. In this study, the Model of Filtering Effects in Reporting Work Injuries described by Webb et al.[36] is used, in which filters that may impede or compromise the needed flow, creating underreporting detectable in the following steps. Therefore, filters are partial barriers for recording. They vary and are influenced by individual aspects of the victim, of the professionals in charge of recording, and the information system management as well[36]. This Model facilitates the understanding of the reasons for underreporting in each step of information flows[35], and demonstrates the feasibility of multiple data sources usage for imputation, when needed to enhance records quality[35,37]. Strategies to improve data quality need to be based on the causes and effects to each filter and barriers in their respective contexts[35].

To make it simple, filters are classified in two types: missed death reporting in the information system; death is recorded but not its work-relatedness (Figure 1). Studies addressing causes of these filters show: 1) insufficient training of professionals involved[38]; 2) poor motivation and awareness about the relevance of work-relatedness recording[39,40]; 3) concerns about legal implications, particularly among those in charge of ATF registration[41]; 4) lack of equipment or other needed resources for notification or to investigate the death work-relatedness[42]; and 5) pressures from employers, lawyers, colleagues, health professionals and even family members to omit the work-relatedness recording due to pecuniary interests[43].

It is possible that these barriers and filters have been intensified due to transformations in the world of work that have been taking place in Brazil, such as the reduction on outsourcing restrictions and the resulting increase in job precariousness[44]. Other barriers and filters, however, may be indirect. For instance, the Technical Epidemiological Nexus of Prevention (NTEP) was

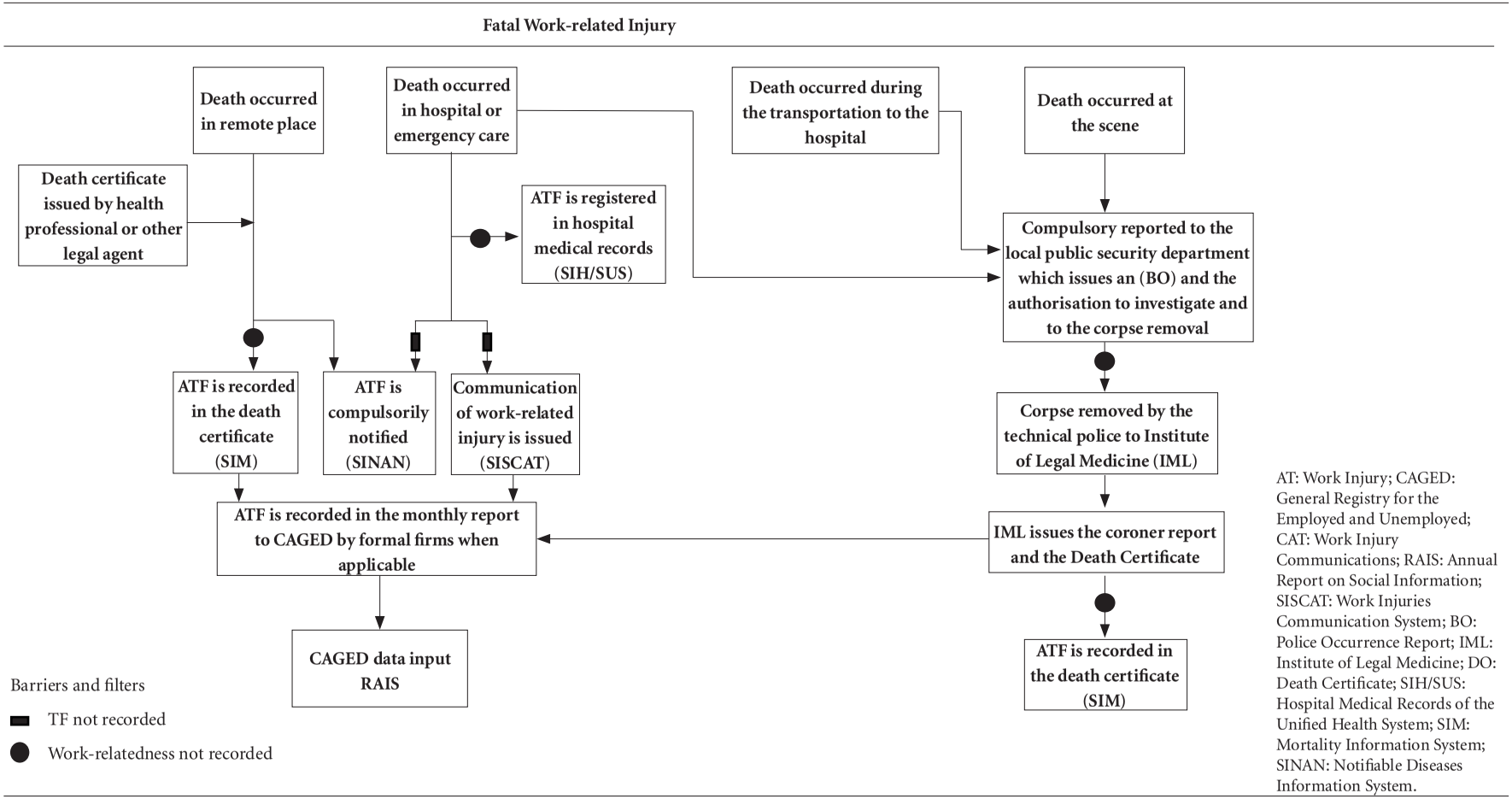

Figure 1. Fatal work-related injuries (ATF), recording and data flow across information systems in Brazil, and respective barriers and filters.

created in 2007 by the INSS, to promote the identification and recording of the work-relatedness of injuries and illnesses for registered workers by qualified physicians. Consequently, work-related compensation benefits could be granted, independently of CAT emission[27,45]. Unfortunately, because the amount of such benefits is used to define the value of the company's payments to the compulsory Workplace Personal Injury Insurance, this may cause the development of strategies to cover up ATF. In addition, it is noticeable the weakening of health-related guidelines in policies adopted by many unions and worker movements over recent decades[32].

Conclusion

This study verified that ATF data in Brazil can be identified in several information systems of distinct government institutions. But the lack of key unique across these systems, which hinders the use of multiple sources to improve coverage and data quality and, consequently, compromising accuracy and completeness of epidemiological estimates. However, the complexity of the identification and recording of ATF is clear. In many cases, their non-recognition may be intentional, resulting from pecuniary interests and/or to avoid legal penalties. The existence of important barriers and filters is presumable, which needs studies focusing the quality and coverage of information systems used for ATF investigation. We emphasize that an appropriate ATF recording precedes and allows the planning of efficient preventive public initiatives.

Collaborations

AG Batista defined the research question and methodological strategy, raised the documents and extracted the databases, analyzed the records and wrote the manuscript. VS Santana, was the main guideline of the study, collaborating in the problematization of the study question, in the literature review and definition of the methodological approach, theoretical aspects and in the drafting of the manuscript. S Ferrite, was co-mastermind contributing in the construction of the architecture of the general and bibliometric study, especially, and in the writing.

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