# Cattle movement as a risk factor for epidemics

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## Summary

Cattle movement is one of the most important risk factors for the occurrence of an epidemic. It is a legal requirement in Switzerland that every cattle movement be reported, and this information is held in the Swiss cattle movement database (Tierverkehrsdatenbank, TVD). Using this data we examined all movements, focusing on the geographical distribution of these movements in relation to the spread of epizootic diseases. We considered the period 01 January 2011 through 30 January 2012, in which a total of 786'462 cattle were moved. Looking at premises individually, a maximum of 901 possible transfers of an infectious agent were found on a specific day after the arrival of another cattle.

Furthermore, we found that there were more cattle movements in summer than in winter, due to movements of cattle to and from alpine pastures. There were also prominent regional differences. On the first day after the arrival of a cattle there was a minimum of zero and a maximum of 99'168 possible transfers of an infectious agent. Nevertheless, in most cases there were no cattle moved on the first day following the arrival of a cattle (91.4%).

In terms of our epizootics of interest, the following numbers of cattle were moved within the relevant incubation periods: 19'779'551 possible transfers for the Lumpy skin disease, with an incubation period of 28 days; 9'891'665 or 15'025'741 possible transfers for foot and mouth disease, depending on the incubation period of 14 or 21 days; 15'025'741 possible transfers for cattle plague and vesicular stomatitis, both with an incubation period of 21 days.

The presented data show a large cattle traffic in Switzerland, and therefore suggest that it is very seldom that an infectious agent is able to start an epidemic.

**Keywords:** bovine, epidemics, cattle movement, incubation period

## Rinderverkehr als Risikofaktor für Epidemien

Tierbewegung ist einer der wichtigsten Risikofaktoren für das Auftreten einer Epidemie. In der Schweiz ist gesetzlich vorgeschrieben, dass jede Bewegung von Nutztieren gemeldet und in der Tierverkehrsdatenbank (TVD) erfasst wird. Anhand dieser Daten haben wir für das Jahr 2011 alle Bewegungen untersucht und unser Augenmerk auf die geografische Verteilung dieser Bewegungen in Bezug auf die Verbreitung von Tierseuchen gelegt. Zwischen dem 1. Januar 2011 und 30. Januar 2012, wurden insgesamt 786'462 Rinder verschoben. Maximal 901 Kontakte mit der Möglichkeiten der Übertragung eines infektiösen Agens fanden an einem bestimmten Tag nach Ankunft eines anderen Rindes statt. Aufgrund der Bewegungen von Rindern nach und von Alpen fanden im Sommer mehr Rinderbewegungen statt als im Winter. Es gab auch bedeutende regionale Unterschiede. Am ersten Tag nach Ankunft eines Rindes gab es ein Minimum von 0 und ein Maximum von 99'168 möglichen Kontakten für die Übertragung eines infektiöses Agens. In den meisten Fällen erfolgte kein Rinderverkehr am ersten Tag nach der Ankunft eines Rindes (91.4%).

In Bezug auf Rinderseuchen von Schweizer Interesse, ergaben sich folgende Rinderkontakte innerhalb der relevanten Inkubationszeiten: 19'779'551 für die Lumpy skin - Krankheit, mit einer Inkubationszeit von 28 Tagen; 9'891'665 oder 15'025'741 für die Maul- und Klauenseuche (MKS), je nach der Inkubationszeit von 14 oder 21 Tagen; 15'025'741 für die Rinderpest und die vesikuläre Stomatitis, beide mit einer Inkubationszeit von 21 Tagen.

Die Daten weisen auf einen grossen Tierverkehr in der Schweiz hin. Dies ist ein Hinweis, dass ein infektiöses Agens nur selten eine Epidemie starten kann.

**Schlüsselwörter:** Rind, Epidemie, Tierverkehr, Inkubationszeit

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## Introduction

The control of epidemics of diseases in cattle is mandatory in Swiss law (Anonymous, 2013a). In 2011, Switzerland was free from all diseases of the former list A of the OIE (Office International of Epizooties) with the exception of blue tongue disease. Also in 2011 Switzerland was free from cattle-related cattle diseases such as rabies, tuberculosis, brucellosis, infectious bovine rhinotracheitis (IBR) and enzootic bovine leucosis (EBL) (Anonymous, 2012).

The duration between introduction of a pathogen into a country and the first discovery of an outbreak is obviously a high risk period, as no targeted intervention measures are in place. Internationally, Switzerland is a country with relatively small herd sizes and a low density of livestock (Anonymous, 2013b). Cattle transportation, therefore, is a key issue in the spread of cattle disease. In Switzerland, all premises which keep cloven-hoofed cattle must be registered, and all cattle movements and disposals, as well as perish of bovine, must be reported to the Swiss cattle movement database (Tierverkehrsdatenbank, TVD) within three working days. The purpose of this study was to elucidate the importance of cattle transportation in Switzerland, with special focus on the risk of the spread of cattle epidemic within the prepatence and incubation period.

The duration between a cattle arriving at a premise, and another one leaving it, influences the risk of spreading a pathogen, especially if cattle are passed on during the incubation period. It is particularly dangerous if a pathogen is already excreted by an infected cattle during the incubation period, i.e. if the prepatence is shorter than the incubation period (Dubé et al., 2009). This is particularly important in cases where a cattle departs soon after another has arrived, as the cattle leaving could have become infected, and possibly be spreading the pathogen unnoticed.

**Table 1**: Incubation periods for the diseases used in this study. For diseases see material and method section. Not all incubation periods come from the TSV (Tierseuchenverordnung) or the OIE (Office international d'épizootiologie). Certain data matches the longest incubation period found in the literature, if no data are found in the TSV and OIE manuals.

| Disease | Incubation time |
|---|---|
| Dermatitis nodularis | 28 days (OIE) |
| Foot and mouth rot disease (FMD) | 21 days (TSV), 14 days (OIE) |
| Rinderpest | 21 days (OIE) |
| Stomatitis vesicularis | 21 days (OIE) |
| Bovine virus diarrhoe virus (BVD) | 14 days (TSV) |
| Infectious bovine Rhinotracheitis (IBR) | 30 days (TSV), 21 days (OIE) |
| Leptospirosis | 20 days (TSV) |
| Salmonellosis | 8 days (TSV) |
| Campylobacteriosis | 5 days (TSV) |
| Cryptosporidiosis | 7 days (TSV) |

## Cattle, Material and Methods

In this study, the term "cattle" is representative for all cattle species, sex and ages (Meier, 2014). In the context of this study only cattle diseases with an incubation period of maximum 30 days which can be transmitted horizontally were considered. The incubation period according to Ernst et al. (1979) is defined as the time from infection until the outbreak of the disease. It varies largely depending on the type of pathogen and also for the same disease. The duration of incubation period is of considerable importance in infectious disease epidemiology, because an infected cattle showing no signs of disease can spread disease within this period (Eckert, 2008). Prepatence is a term used mainly in parasitology and Eckert et al. (2008) defined it as the time from the infection of a host with infectious stages of a parasite species to the detection of it in sample material regardless of symptoms (Fèvre et al., 2006). On this basis, the term prepatence in this study is used for each pathogen to describe the period of time between infection and the spreading of pathogens. Only cattle diseases, for which the prepatence is shorter than the incubation period, or those for which it could not be ruled out, were examined. In this study, disease transmission could occur before the appearance of symptoms of disease.

The longest possible incubation period was assumed, as long as it was less than 30 days, according to the OIE terrestrial cattle health code (OIE) or the Swiss cattle disease ordonnance (Tierseuchenverordnung, TSV) (Tab. 1). The age of the cattle was not evaluated. Each cattle movement was considered a risk for the spread of disease.

### Study-unit

The study-unit is the "possible transfer" of one infectious agent by an outgoing cattle after an incoming cattle within the incubation period for one disease. Therefore if 10 cattle move in and 10 cattle move out, this will count for 100 in the possibility of spreading a certain disease. The rationale for this calculation is the basic possibility that each cattle entering a premise can infect with one disease each other cattle on the premise at the day of arrival and due to the incubation period can not clinically be detected. Therefor movement has a higher risk for spreading a disease than after the incubation period is passed when the disease is clinically recognized. The results and figures show the maximum possible dispersion or transfer of an infectious agent.

### Database

The investigated data included 1'168'301 single cattle movement reports from 37'584 premises. The data were kindly provided by Identitas AG (Berne, Switzerland), a federal government owned company, which is responsible for the registration of cattle transport in Switzerland (Anonymous, 2013c). We have not considered all types of movements and specifically excluded definitive exportation out of Switzerland, deadly accident on the premise, premise slaughter, self-consumption, temporary export, as well as sales to the slaughterhouse. Thus in total 786'462 movements were examined, representing 67% of all single cattle movements. The study time period consisted of 13 months from January 1st 2011 through January 30th 2012, hence the risk emanating from initial movements at the end of 2011 with a lag time of 30 days are included.

### Data handling and statistics

The raw data in CSV (comma separated values) with premise number where the cattle came from, premise number where the cattle arrived, zip code of the departure premise, Swiss community number of the departure premise, zip code of the arriving premise, Swiss community number of the arriving premise, date of transfer, for each cattle moved, were imported into R (R Core Team, 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/). From these data a spreadsheet was created with permutating cases, i.e. each possible contact between two cattle was basically considered, after a cattle stabling. This gave a matrix of 618'524'050'369 lines (each possible movement: each cattle has contact to each other) by 8 columns. These data were transferred in STATA 12 by means of the program "StatTransfer 10". This resulted in a table with 786'463 lines and 400 columns. The managing of data and the statistical analyses were performed with the program STATA 12 (StataCorp., 2011, STATA statistical software: release 12; College Station, TX, USA; StataCorp LP). The average staying of a cattle on one premise was calculated by the time difference between birth or arriving and the leaving of the respective premise. The normal distribution was tested by the Wilk-Shapiro-test. All graphical analyses were conducted using ArcGIS 10.1.2. The shape-files are provided by „Amtliche Vermessung Schweiz/swisstopo". The ZIP-code was chosen as the unit of area, because veterinarian are more used to ZIP-codes than to Swiss community code. The possible contact rate within the incubation period was aggregated by ZIP-code. Because cattle movement in the communities has a skewed distribution (Keeling et al., 2010), once a natural break graduation (Jenks) and once a self-imposed graduation for better detecting hotspots was selected.

## Results

Between January 1st 2011 and January 30th 2012 786'462 possible transfers of cattle from a total of 37'584 premises were recorded. The possible transfers were related to 46'725 different receiving premises, which can be associated with 2'798 different postcodes or 2'267 different municipality codes. The number of the receiving premises is larger than the sending premises due to the transfer of a bovine to several premises within the incubation period. It is shown an overview of how often in Switzerland within the first 30 days after arrival of one cattle on a premise, one or more cattle left the same premise within 2011 (Tab. 2). After the arrival of a cattle on a premise between 0 and 901 possible transfers 3 to 6 days after the arrival of the first cattle were counted for. The average staying of a cattle on one premise is

**Table 2:** Number of moved cattle per premise after days of stabling. Day stands for the day of the movement after arrival of one cattle. N stands for the total movements in Switzerland on a respective day after arrival of one cattle. Minimum and median are skipped because entries (= 0) do not vary between days inspected.

| day | mean | SD | SE (mean) | max |
|---|---|---|---|---|
| 1 | 1.128 | 11.675 | 0.013 | 310 |
| 2 | 0.756 | 8.907 | 0.010 | 350 |
| 3 | 0.836 | 14.307 | 0.016 | 901 |
| 4 | 2.082 | 36.489 | 0.041 | 901 |
| 5 | 0.725 | 16.750 | 0.018 | 901 |
| 6 | 0.554 | 5.491 | 0.006 | 901 |
| 7 | 1.061 | 10.994 | 0.012 | 382 |
| 8 | 0.787 | 6.909 | 0.007 | 299 |
| 9 | 0.656 | 5.807 | 0.006 | 297 |
| 10 | 0.819 | 8.398 | 0.009 | 330 |
| 11 | 0.667 | 6.873 | 0.007 | 299 |
| 12 | 0.692 | 7.140 | 0.008 | 406 |
| 13 | 0.799 | 6.489 | 0.007 | 407 |
| 14 | 1.009 | 8.287 | 0.009 | 331 |
| 15 | 0.997 | 8.514 | 0.009 | 463 |
| 16 | 0.919 | 6.844 | 0.007 | 454 |
| 17 | 0.905 | 8.308 | 0.009 | 463 |
| 18 | 0.991 | 10.299 | 0.011 | 331 |
| 19 | 0.810 | 7.802 | 0.008 | 406 |
| 20 | 0.726 | 5.908 | 0.006 | 272 |
| 21 | 1.177 | 8.848 | 0.009 | 463 |
| 22 | 0.878 | 6.981 | 0.007 | 385 |
| 23 | 0.887 | 8.540 | 0.009 | 463 |
| 24 | 0.731 | 6.175 | 0.006 | 454 |
| 25 | 0.787 | 8.281 | 0.009 | 315 |
| 26 | 0.840 | 8.442 | 0.009 | 330 |
| 27 | 0.806 | 8.188 | 0.009 | 385 |
| 28 | 1.112 | 11.225 | 0.012 | 386 |
| 29 | 0.746 | 6.273 | 0.007 | 407 |
| 30 | 0.961 | 7.854 | 0.008 | 406 |

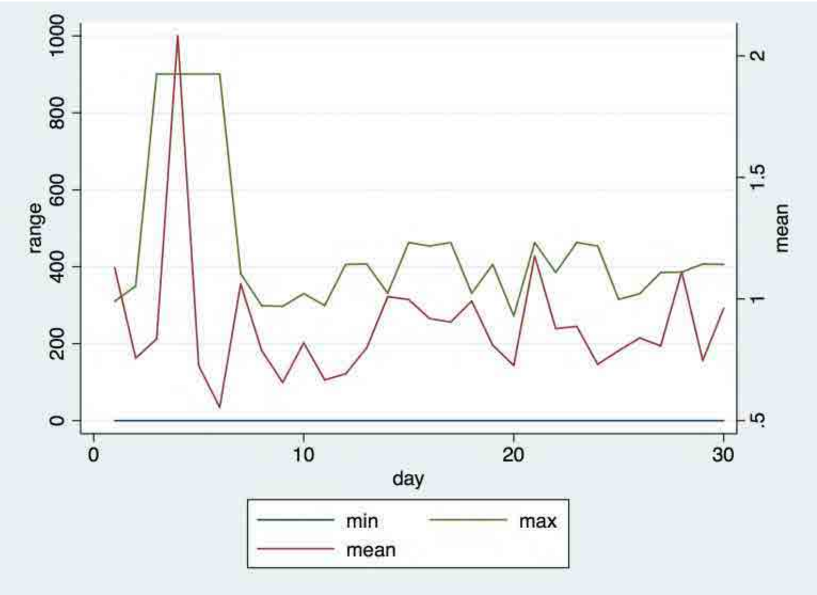


**Figure 1:** Minimum, average and maximum number of possible cattle contacts by moved cattle per premise following an initial movement up to 30 days later.

skewed due to the fact of wide calf meat production in Switzerland, where the meat calves are kept only for 8 to 12 weeks on a calf fattening premise ($p<0.01$). The sum of possible transfers calculated from the cattle movement database in Switzerland by days after arrival of a cattle multiplied by the outgoing cattle within the respective incubation period is shown in Figure 1. The median for possible transfers by community, i.e. postal code, per day is always zero, the mean is always between 0.55 and 2.08 and the standard deviation varies from 5.49 to 36.49. Clearly the data is highly skewed. The 901

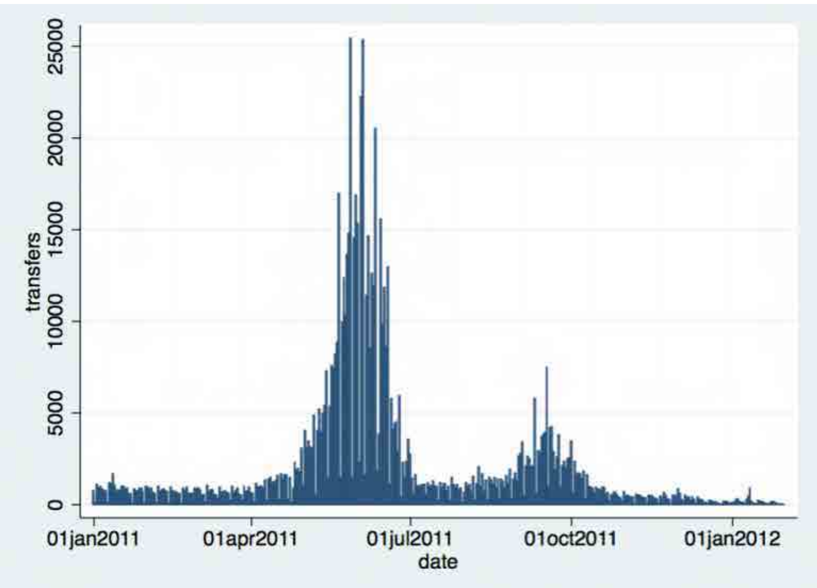


**Figure 2:** Total possible cattle contacts by moved cattle by date (n = 786'462).

cattle moved out between 3 and 6 days after the arrival of one cattle in one community, come from a veal fattening trade center. For the cattle diseases deemed relevant for Switzerland, a summary of the number of possible transfers and the respective incubation period are presented in Tab. 1 and 2.

From January to March and from November to January, only rarely over 1'000 possible transfers are counted for on a day within Switzerland, with a minimum of 4 (Fig. 1 and 2). In the summer months between April and October only occasionally less than 1'000 possible transfers per day are realized, with peaks over 25'000. On 19 days over 10'000 possible transfers in total per day were counted for (Tab. 3). All of these days are in May or June (Fig. 1 and 2). A transfer over more than one premise at the same day was counted as more than one transfer. Especially meet calves can be transferred from the premise they were born over a trading premise to a meet production premise on the same day.

Of the premises receiving cattle on December 25, no cattle were moved away a day afterwards by any one of the premises. This shows the influence of holydays. The maximum number of possible transfers just one day after the arrival of a cattle on a premise is on September 20, 2011 with 99'168 possible transfer of an infectious agent. It is shown how often cattle are moved from a certain premise during the first 30 days after the arrival of a cattle (Tab. 4).

This table clearly shows that one day after the arrival of one cattle in most cases no cattle are moved. This applies to 718'626 of the original 786'462 possible transfers (91.4%). Fig. 3 and 4 clearly show that most of the possible transfers take place in the Alpine region, where breeding and alpine pasturing are the dominant character. This statement applies only to the northern slope of the Swiss Alps and not to the canton of Valais or Ticino. It is apparent that there are "hotspots" concerning cattle transport and distribution centers.

## Discussion

Our study-unit of the "possible transfer" of one infectious agent by one outgoing cattle after an incoming cattle within the incubation period for one disease is different to the contact rate. Our calculation includes two following steps of cattle movement: The incoming cattle within the incubation period and the outgoing cattle within the incubation period. For reason of calculation the incoming cattle is only infected with one infectious agent where as the outgoing cattle can be infected with several infectious agents.

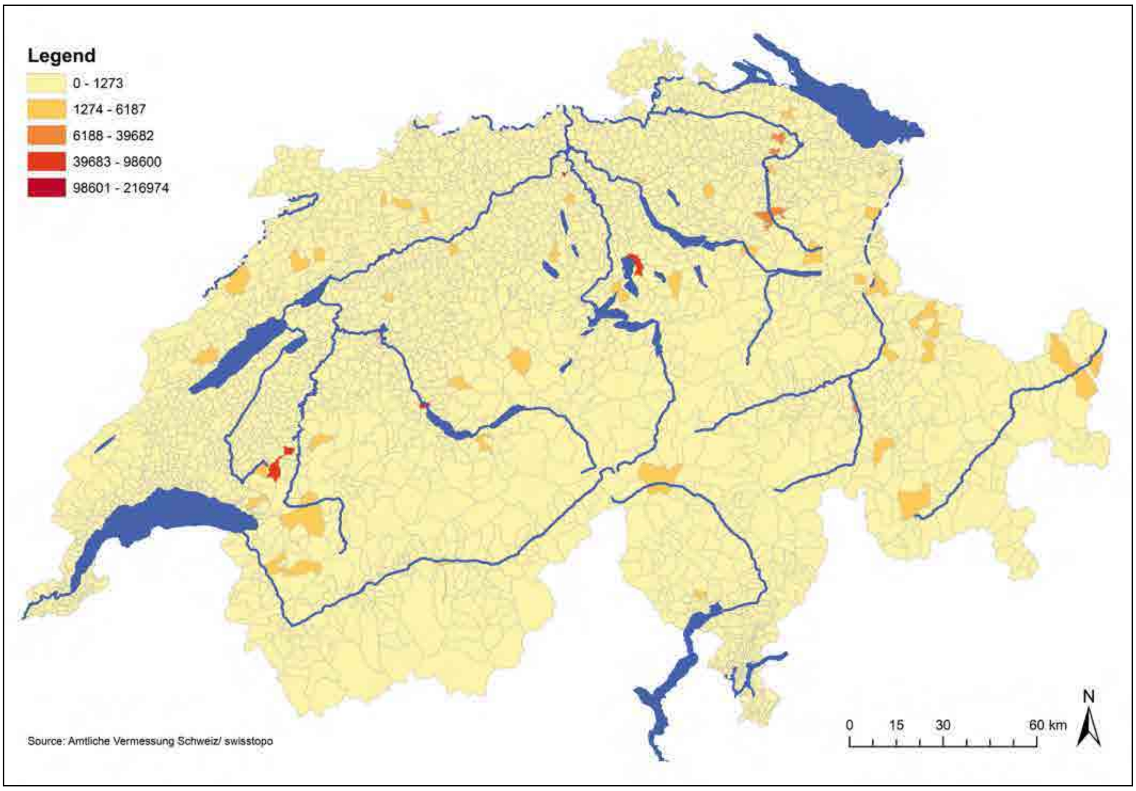


**Figure 3:** Possible cattle contacts by cattle movement on day 1 after arriving of a single cattle on a premise summarized by zip-code-zones in Switzerland during one year. Color gradation is by natural breaks (Jenks).

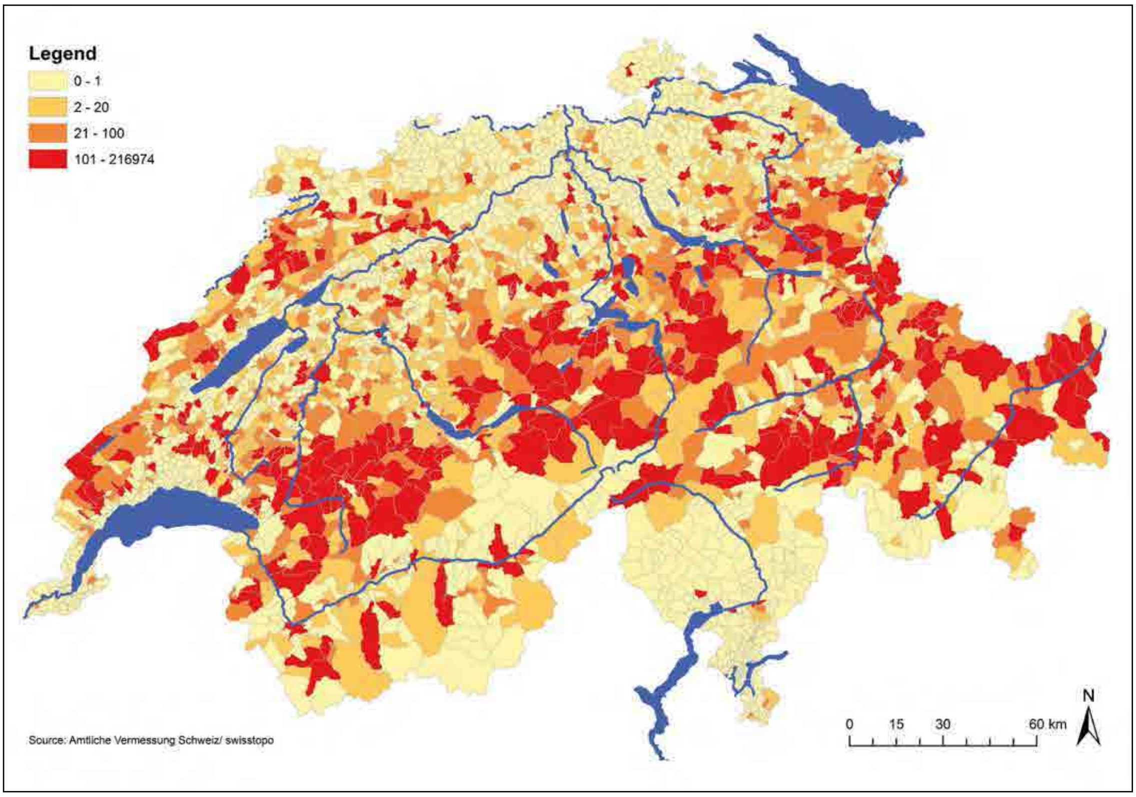


**Figure 4:** Possible cattle contacts by cattle movement on day 1 after arriving of a single cattle on a premise summarized by zip-code-zones in Switzerland during one year. Color gradation is by convenience interval for better highlighting hotspots.

**Table 3:** Nationwide possible transfers by cattle movement (N = 786'462) within the incubation period after stabling one cattle. Days = incubation period, OIE = incubation period according to OIE, TSV = incubation period according to the Swiss animal disease ordonnance.

| Infectious agent | days | Sum | SE | 95% CI | |
|---|---|---|---|---|---|
| Campylobacteriosis | 1-5 | 4'348'246 | 40'580.64 | 4'268'709 | 4'427'783 |
| Cryptosporidiosis | 1-7 | 5'618'822 | 43'152.04 | 5'534'245 | 5'703'399 |
| Salmonellosis | 1-8 | 6'238'393 | 44'561.49 | 6'151'054 | 6'325'732 |
| BVD, MKS (OIE) | 1-14 | 9'891'665 | 51'113.80 | 9'791'484 | 9'991'846 |
| Leptosporidiosis, FMD (TSV), Rinderpest, Vesicular Stomatitis, | 1-20 | 1.41e+07 | 59'670.86 | 1.40e+07 | 1.42e+07 |
| IBR (OIE) | 1-21 | 1.50e+07 | 61'866.43 | 1.49e+07 | 1.51e+07 |
| Dermatitis nodularis | 1-28 | 1.98e+07 | 72'719.82 | 1.96e+07 | 1.99e+07 |
| IBR (TSV) | 1-30 | 2.11e+07 | 76'196.55 | 2.10e+07 | 2.13e+07 |

**Table 4:** Frequency distribution of possible transfers during the first 30 days after the arrival of a cattle. Day 0 has the meaning that an animal left the premise the same day of one arriving.

| Day | N |
|---|---|
| 0 | 718'626 |
| 1 | 23'330 |
| 2 | 10'058 |
| 3 | 6'140 |
| 4 | 3'762 |
| 5 | 2'861 |
| 6 | 2'491 |
| 7 | 1'600 |
| 8 | 1'500 |
| 9 | 1'215 |
| 10 | 944 |
| 11 | 911 |
| 12 | 946 |
| 13 | 631 |
| 14 | 594 |
| 15 | 517 |
| 16 | 408 |
| 17 | 377 |
| 18 | 362 |
| 19 | 279 |
| 20 | 159 |
| 21 | 285 |
| 22 | 256 |
| 23 | 354 |
| 24 | 484 |
| 25 | 252 |
| 26 | 136 |
| 27 | 105 |
| 28 | 114 |
| 29 | 120 |
| 30 | 126 |

In Switzerland 786'462 possible transfers occurred from January 1st 2011 through January 30th 2012 amongst a total cattle population of over 1.5 million. In the first 30 days after the arrival of cattle on a premise a total of possible cattle contacts with the possibility of transferring infectious agents were found to be between 500'000 and 1'000'000. However, in the vast majority of cases (91.4%), no cattle were moved out on the first day after the arrival of a new cattle onto the premise. This study restricts their analysis to the time relevant for spread of cattle disease, i.e. 30 days after the purchase of cattle in one premise. This approach is justified by the incubation period of infectious diseases relevant to Switzerland. This study does not follow the guidelines for the implementation of a risk analysis (e.g. FAO guidelines), which include the elements release assessment, exposure assessment, consequence assessment and risk estimation (Kiss et al., 2008; Dube et al., 2009; Keeling et al., 2010). Due to lack of information, the characteristic of the trade network between certain areas in Switzerland, was not evaluated (Bansal et al., 2007; Smieszek, 2009).

Through analyses of the cattle at risk of the possible spread of disease by movements, it is noticeable that a very large number of these movements take place within the incubation period of the diseases examined. For all cattle diseases classified as relevant for Switzerland, there are several million possible transfers, which could theoretically lead to the spread of disease. The large amount of cattle transported in the first days after the new stabling of one cattle represents a potential risk for the spread of disease.

It has been pointed out in previous studies (Miller, 2009; Tildesley et al., 2010), that cattle markets specifically, represent a high risk for the spread of infectious cattle diseases. These places serve as points of contact between infected herds and the displacement of the cattle leads to a rapid propagation over long distances (Matthews et al., 2005; Dürr et al., 2014). The possible transfers in Switzerland for the study period of one year was examined in this work. Under these conditions, a large number of possible transfers were discovered, which should be considered as a potential risk for the transmission and later spread of a pathogen. Looking at the distribution of cattle traffic throughout the year, it is noticeable that more cattle are moved during the summer months than during the winter season, which is connected with the practice of summer grazing in the Alps. The age of the cattle and the sex were not evaluated in this study. For the cattle diseases classified as relevant for Switzerland, there is no indication in the literature that the sex of the cattle would have any special impact on the epidemiology. Different risk patterns due to different operating modes, not every premise keeps all age and gender groups, were not considered. Cattle traffic with foreign countries has not been examined. In a further study, it would be interesting to investigate how many cattle are exported as well as how many are imported and how these data seasonally and geographically behave in relation to safety quarantine issued by federal law. In this study, it was calculated how often possible transfers of pathogens could occur before the end of the incubation period. It has to be mentioned that the incubation period for many cattle diseases is highly variable.

On the basis of the data analyzed, it can be stated that in 2011 a huge number of possible transfers from premise to premise took place within Switzerland, and in a period of time in which infectious agents could be spread unrecognized. Concerning disease outbreaks, these huge possible transfers of an infectious agent took place only in 9.6% of all movements, i.e. within the incubation period of the above mentioned diseases. Our analyses emphasize the importance of accurate cattle registration and monitoring, to enable rapid contact tracing of cattle, which are possibly infected and in the incubation period to take counter measures against further proliferation. Happily, even with the large number of cattle movements, resulting in possible contacts, which occur in such a small and densely populated country as Switzerland, the frequency of epidemic outbreaks is very low, concluding that the spread of infectious disease in cattle is a rare event.


## Les déplacements des bovins en tant que facteur de risque épidémiologique

Les déplacements d'animaux constituent un des risques les plus importants pour la survenance d'une épidémie. En Suisse, il est prescrit que chaque déplacement d'un animal de rente doit être annoncé et saisi dans la Banque de Données sur le Trafic des Animaux (BDTA). Sur la base de ces annonces, nous avons examiné tous les déplacements de l'année 2011 et concentré notre attention sur leur répartition géographique par rapport à l'extension des maladies animales contagieuses. Entre le 1er janvier 2011 et le 30 janvier 2012, 786'462 bovins au total ont été déplacés. Ce sont au maximum 901 contacts avec possibilité de transmission d'un agent infectieux qui se sont produits un jour donné après l'arrivée d'un nouvel animal. Vu les déplacements liés à la montée et à la descente de l'alpage, il y a eu plus de déplacements en été qu'en hiver. On constate également des différences régionales. Le premier jour après l'arrivée d'un bovin, il existait au minimum 0 et au maximum 99'168 contacts possibles pour la transmission d'un agent infectieux. Dans la plupart des cas (91.4%), il ne se produisait pas de trafic de bovins le jour suivant l'arrivée d'un animal. En ce qui concerne les maladies contagieuses des bovins revêtant un intérêt en Suisse, on a relevé les contacts de bovins suivants durant la période d'incubation: 19'779'551 pour la lumpy skin disease, avec un temps d'incubation de 28 jours, 9'891'665 ou 15'025'741 pour



## Trasporto di bestiame come fattore di rischio per le epidemie

Il trasporto degli animali è uno dei principali fattori di rischio per la comparsa di un'epidemia. In Svizzera, la legge richiede che qualsiasi movimento di animali da reddito venga notificato e riportato nella banca dati sul traffico di animali (BDTA). Sulla base di questi dati, abbiamo esaminato tutti i movimenti per l'anno 2011 e posato uno sguardo sulla distribuzione geografica di questi movimenti in relazione alla propagazione delle malattie. Tra il 1° gennaio 2011 e il 30 gennaio 2012 sono stati spostati un totale di 786'462 bovini. Un massimo di 901 contatti con le possibilità di trasmissione di un agente infettivo si sono svolte in un determinato giorno dopo l'arrivo di un altro bovino. A causa dei movimenti di bestiame da e verso le Alpi, in estate si sono contati un numero maggiore di movimenti di bovini che d'inverno, inoltre si sono riscontrate anche significative differenze regionali. Il primo giorno dopo l'arrivo del bestiame, si sono verificati da un minimo di 0 a un massimo di 99'168 possibili contatti per la trasmissione di agenti infettivi. Nella maggior parte dei casi, nessun trasporto di bestiame è stato effettuato il primo giorno dopo l'arrivo dei bovini (91.4%). In relazione alle patologie bovine di interesse svizzero, i seguenti contatti di bovini si sono sviluppati entro i tempi di incubazione rilevanti: 19'779'551 per la malattia dermatosi nodulare con un periodo di incubazione di 28 giorni; 9'891'665 oppure 15'025'741 per l'afta epizo-

la fièvre aphteuse, selon qu'on considère un temps d'incubation de 14 ou de 21 jours, 15'025'741 pour la peste bovine et la stomatite vésiculeuse, toutes deux avec un temps d'incubation de 21 jours. Ces chiffres démontrent un grand trafic d'animaux en Suisse. C'est une indication qu'un agent infectieux ne peut que rarement faire démarrer une épidémie.

otica (FMD), a seconda del periodo di incubazione di 14 e di 21 giorni; 15'025'741 per la peste bovina e la stomatite vescicolare, entrambe con un periodo di incubazione di 21 giorni. I dati indicano che in Svizzera ci sono forti movimenti di animali. Dallo studio possiamo dedurre che un agente infettivo solo raramente può iniziare un'epidemia.

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