**SUPPLEMENTAL MATERIALS**

**Supplemental Table S1. Search terms used for initial article selection in Ovid-Medline**

|  |  |
| --- | --- |
| **Line #** | **Search Terms** |
| 1. | Cross Infection/ or “Healthcare-Associated Pneumonia”/ or “Infectious Disease Transmission, Professional-to-Patient”/ or “Infectious Disease Transmission, Patient-to-Professional”/ |
| 2. | ((Cross adj1 Infection\*) or (((Health adj1 Care) or Healthcare or nurse\* or physician\*) adj3 (acquired or associated or infected or Infection\* or (tested adj3 positive))) or (hospital adj3 outbreak\*) or nosocomial).ti,ab,kf. |
| 3. | 1 or 2 |
| 4. | Cluster Analysis/ or Geographic Mapping/ or Spatio-Temporal Analysis/ |
| 5. | ((chain or chains or cluster or clustering or clusters or geographic\* or heat or indirect or spatial or (spatio adj1 temporal) or spatiotemporal or temporal or time or visual) adj4 (analysis or distribution or distributions or identification or map or mapped or mapping or representation or transmission)).ti,ab,kf. |
| 6. | dotmapper.ti,ab,kw. |
| 7. | 4 or 5 or 6 |
| 8. | 3 and 7 |
| 9. | limit 8 to (english language and yr=”1985 – 2022”) |
| 10. | 9 not (animals/ not humans/) |

**Supplemental Table S2. Data abstraction elements descriptions, categorical options (where pertinent), and examples**

|  |  |
| --- | --- |
| **Data Element** | **Description** |
| Basic Article Citation | Author(s), article title, journal title, and year of publication  |
| Type of Healthcare Facility | Acute care hospital, long-term care facility, behavioral health clinic, etc.  |
| Infectious Pathogen | SARS-CoV-2, MERS-CoV, influenza, *Clostridioides difficile*, needs to be described by healthcare transmission |
| Infectious Pathogen Type | Virus, bacteria, fungus  |
| Number and Type of Cases Defined/Identified | Ex. 3 healthcare workers, 5 patients |
| Status of Infected Individuals | Healthcare worker (including type of worker) or patient  |
| Type of Transmission | Direct, Indirect, Probable, Suspected  |
| Types of Surveillance | Active surveillance (asymptomatic testing), retrospective surveillance, prospective surveillance  |
| Methods to Determine Genetic Relatedness | Genus or genus & species, antimicrobial resistance phenotype, intermediate genetic relatedness testing (Pulsed-field gel electrophoresis (PFGE), Multilocus sequence typing (MLST), spa typing) etc.  |
| Scope of Transmission | Multiple floors, multiple buildings, multiple units, single unit/department  |
| Type of Visualization | Flow chart, line list, Gantt chart, heat map, cluster map, plotted cases in a floor plan, transmission network  |
| Software Used for Creating Visualization | GIS, R, Excel, DotMapper, etc.  |
| Spatial Elements | Emergency department or other unit of space if used (i.e. unit, floor, facility) |
| Temporal Elements | Hours, days, months |
| Other Features | Incubation period, specific symptoms, laboratory test details such as specimen location or Ct value, nature of interaction  |

**Supplemental Table S3. Included articles with PubMed links and data visualization figure numbers**

| ***Pathogen***Study | **PMID** | **Figure #** |
| --- | --- | --- |
| ***Clostridioides difficile*** |  |  |
| Cherifi et al. 2006 | PMID: [17080377](https://pubmed.ncbi.nlm.nih.gov/17080377/) | Figure 3 |
| Jia et al. 2016 | PMID: [27411304](https://pubmed.ncbi.nlm.nih.gov/27411304/) | Figure 1, Figure 4 |
| Pai et al. 2020 | PMID: [32000873](https://pubmed.ncbi.nlm.nih.gov/32000873/) | Figure 2 |
| **Coronaviruses** |  |  |
| **SARS-CoV-1** |  |  |
| Shen et al. 2003 | PMID: [15030693](https://pubmed.ncbi.nlm.nih.gov/15030693/) | Figure 2 |
| Varia et al. 2003 | PMID: [12925421](https://pubmed.ncbi.nlm.nih.gov/12925421/) | Figure 2 |
| **SARS-CoV-2** |  |  |
| Abbas et al. 2021 | PMID: [34461177](https://pubmed.ncbi.nlm.nih.gov/34461177/) | Figure 3 |
| Borges et al. 2021 | PMID: [33916205](https://pubmed.ncbi.nlm.nih.gov/33916205/) | Figure 1, Figure 2b |
| Klompas et al. 2021 | PMID: [34599821](https://pubmed.ncbi.nlm.nih.gov/34599821/) | Figure 2 |
| Lee et al. 2021 | PMID: [34155840](https://pubmed.ncbi.nlm.nih.gov/34155840/) | Figure 1, Figure 2 |
| Pérez-Lago et al. 2021 | PMID: [34346709](https://pubmed.ncbi.nlm.nih.gov/34346709/) | Figure 1, Figure 2 |
| Wee et al. 2020 | PMID: [32391746](https://www.ncbi.nlm.nih.gov/pubmed/32391746) | Figure 2 |
| **Enterobacteriaceae** |  |  |
| Marmor et al. 2020 | PMID: [31611185](https://pubmed.ncbi.nlm.nih.gov/31611185/) | Figure 2 |
| ***Haemophilus influenzae*** |  |  |
| Yang et al. 2010 | PMID: [20170983](https://pubmed.ncbi.nlm.nih.gov/20170983/) | Figure 1 |
| **Hepatitis B & Hepatitis C viruses** |  |  |
| Burns et al. 2011 | PMID: [21530000](https://pubmed.ncbi.nlm.nih.gov/21530000/) | Table 1 |
| Duong et al. 2016 | PMID: [26947224](https://pubmed.ncbi.nlm.nih.gov/26947224/) | Figure 2 |
| Furusyo et al. 2004 | PMID: [15301031](https://pubmed.ncbi.nlm.nih.gov/15301031/) | Figure 2 |
| Spada et al. 2008 | PMID: [18098132](https://pubmed.ncbi.nlm.nih.gov/18098132/) | Figure 3 |
| **Influenza virus** |  |  |
| Javaid et al. 2021 | PMID: [33252647](https://pubmed.ncbi.nlm.nih.gov/33252647/) | Figure 2c, Figures 4a & 4b |
| Pagani et al. 2015 | PMID: [25900487](https://pubmed.ncbi.nlm.nih.gov/25900487/) | Figure 3 |
| Wong et al. 2010 | PMID: [20942655](https://pubmed.ncbi.nlm.nih.gov/20942655/) | Figure 2 |
| ***Klebsiella pneumoniae*** |  |  |
| da Silva et al. 2021 | PMID: [34134752](https://pubmed.ncbi.nlm.nih.gov/34134752/) | Figure 2, Figure 3 |
| Jacobson et al. 2015 | PMID: [26792160](https://pubmed.ncbi.nlm.nih.gov/26792160/) | Figure 2 |
| ***Pneumocystis jirovecii*** |  |  |
| Charpentier E et al. 2017 | PMID: [28726611](https://pubmed.ncbi.nlm.nih.gov/28726611/) | Figure 1 |
| ***Pneumocystis jirovecii*** *(con’t)* |  |  |
| Nevez, G et al. 2018 | PMID: [28943270](https://pubmed.ncbi.nlm.nih.gov/28943270/) | Figure 2 |
| Rabodonirina et al. 2004 | PMID: [15504262](https://pubmed.ncbi.nlm.nih.gov/15504262/) | Figure 4 |
| Vindrios et al. 2017 | PMID: [28549105](https://pubmed.ncbi.nlm.nih.gov/28549105/) | Figure 1 |
| ***Sarcoptes scabiei*** |  |  |
| Tsutsumi et al. 2005 | PMID: [16225694](https://pubmed.ncbi.nlm.nih.gov/16225694/) | Figure 3 |
| ***Mycobacterium tuberculosis*** |  |  |
| Gandhi et al. 2013 | PMID: [23166374](https://pubmed.ncbi.nlm.nih.gov/23166374/) | Figure 4 |
| ***Staphylococcus aureus*** |  |  |
| Kossow et al. 2019  | PMID: [30240815](https://pubmed.ncbi.nlm.nih.gov/30240815/) | Figure 1 |
| Moldovan et al. 2019 | PMID: [31279536](https://pubmed.ncbi.nlm.nih.gov/31279536/) | Figure 1 |

**Supplemental Table S4. Person Type data elements included within each transmission visualization with the total percentage of person types present across studies.**

|  |  |  |
| --- | --- | --- |
| **Study** | **Infectious Pathogen** | **Person Type** |
| **Patients** | **Nurses** | **APP** | **Patient Care Technicians** | **Other HCW** | **Total** |
| Burns et al. | Hepatitis B Virus | 5 | — | — | — |  | 5 |
| Furusyo et al. | Hepatitis C Virus | 40 | — | — | — | — | 40 |
| Duong et al. | Hepatitis C Virus | 19 | — | — | — | — | 19 |
| Spada et al. | Hepatitis C Virus | 5 | — | — | — | — | 5 |
| Javaid et al. | Influenza A Virus | 17 | — | — | — | 28 | 45\* |
| Javaid et al. | Influenza A Virus | 7 |  |  |  | 2 | 9 |
| Pagani et al. | Influenza Virus | 72 | — | — | — | 16 | 88\* |
| Wong et al.  | Influenza Virus | 9 | — | — | — | — | 9 |
| Shen et al. | SARS-CoV-1 | 77 | — | — | — | — | 77 |
| Pérez-Lago et al. | SARS-CoV-2 | 60 | — | — | — | — | 60 |
| Wee et al. | SARS-CoV-2 | — | — | — | — | 41 | 41\* |
| Abbas et al. | SARS-CoV-2 | 31 | — | — | — | 31 | 62\* |
| Varia et al. | SARS-CoV-1 | 23 | 19 | 2 | 5 | 12 | 61 |
| Borges et al. | SARS-CoV-2 | 21 | 10 | — | — | 17 | 48 |
| Klompas et al. | SARS-CoV-2 | 14 | 12 | 10 | 5 | 10 | 51 |
| Lee et al. | SARS-CoV-2 | 9 | 8 | 11 |  | 12 | 40 |
|  | Viruses (Total) | 409 | 49 | 23 | 10 | 169 | 660 |
| Pai et al. | *Clostridioides difficile* | 1,963 | — | — | — | — | 1,963 |
| Jia et al. | *Clostridioides difficile* | 20 | — | — | — | — | 20 |
| Jia et al. | *Clostridioides difficile* | 13 | — | — | — | — | 13 |
| Cherifi et al. | *Clostridioides difficile* | 9 | — | — | — | — | 9 |
| Marmor et al. | Enterobacteriaceae | 14 |  | — | — | — | 14 |
| Yang et al. | *Haemophilus influenzae* | 15 | — | — | — | — | 15 |
| de Silva et al. | *Klebsiella pneumoniae* | 15 | — | — | — | — | 15 |
| Jacobson et al. | *Klebsiella pneumoniae* | 7 | — | — | — | — | 7 |
| Gandhi et al. | *Mycobacterium tuberculosis* | 39 | — | — | — | — | 39 |
| Kossow et al. | *Staphylococcus aureus* | 5 | — | — | — | 3 | 8\* |
| Moldovan et al. | *Staphylococcus aureus* | 547 | — | — | — | — | 547 |
|  | Bacteria (Total) | 2,647 | — | — | — | 3 | 2,650 |
| Nevez et al. | *Pneumocystis jirovecii* | 25 | — | — | — | — | 25 |
| Rabodonirina et al. | *Pneumocystis jirovecii* | 11 | — | — | — | — | 11 |
| Vindrios et al. | *Pneumocystis jirovecii* | 10 | — | — | — | — | 10 |
| Charpentier et al. | *Pneumocystis jirovecii* | 6 | — | — | — | — | 6 |
| Tsutsumi et al. | *Sarcoptes scabiei* | 20 | — | — | — | — | 20 |
|  | Other (Total) | 72 | — | — | — | — | — |

Note: APP, Advanced Practice Practitioners; HCW, healthcare worker; MD, Physician. Not all persons in data visualization were classified as a specific person type

\*These studies did not distinguish between types of healthcare workers; healthcare workers were categorized as “Other”.

Moldovan et al. had 547 cases in the outbreak cluster. In the data visualization, there were at least 547 nodes for all cases, and an unquantifiable amount that represented controls, roommates, and attending physicians.

**Supplemental Table S5. Software programs used to create data visualizations among studies reporting healthcare-associated infectious diseases transmission.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cited Study** | **Data Visualization Type** | **Software** | **What the Software Does** | **Strengths** | **Limitations** |
| Da Silva et al. | Floor plan transmission map | AutoCAD  | Design software that allows for the creation of designs that are both 2 and 3 dimensions | * Demonstrate spatial associations, such as healthcare facility floor plans
 | * Does not intrinsically present temporal elements
* Not designed for entry of individuals and characteristics
* Not oriented to healthcare data
 |
| Da Silva et al. | Floor plan transmission map | QGIS | Geographic information system program that allows for displaying and analyzing spatial data  | * Allows for a large amount of data to be compact into a spatial area
* Individuals can be presented in geographic relationships
 | * Does not intrinsically present temporal elements
* Only a limited number or spectrum of characteristics to assign to individuals
* Not oriented to healthcare data
 |
| Smith & Hayward | Cluster map | DotMapper | Geographic information system program that allows for displaying and analyzing spatial data  | * Allows for a large amount of data to be compact into a spatial area
* Individuals can be presented in geographic relationships
 | * Does not intrinsically present temporal elements
* Only a limited number or spectrum of characteristics to assign to individuals
* Not oriented to healthcare data
 |
| Moldovan et al. | Social network | Pajek 4.09 | Depict, analyze and visualize associations between individuals | * Visualize relationships between an infinite amount of individuals
* Incorporate elements describing the strength or nature of a relationship between two individuals
 | * Does not intrinsically present temporal data
* Does not intrinsically present spatial data
* Can be difficult to discern individual relationships with large clusters
* Not oriented to healthcare data
 |
| Smith et al. | Cluster map | HospMapper | Present individuals and individual characteristics in abstract defined spaces | * Designed for use with healthcare data
* Individuals can be presented with epidemiologic links between individuals
* Can incorporate additional characteristics associated with individuals or location
 | * Data visualization may not be intuitive to new users
* Geographic relationships are abstract rather than on a coordinate plane
* Does not intrinsically present temporal data
 |

*Websites with the listed software:*

* AutoCAD, https://www.autodesk.com/products/autocad/overview?
* QGIS, https://www.qgis.org/
* Pajek 4.09, http://mrvar.fdv.uni-lj.si/pajek/history.htm

*Referenced studies:*

* da Silva PP, da Silva FA, Rodrigues CAS, et al. Geographical information system and spatial-temporal statistics for monitoring infectious agents in hospital: a model using Klebsiella pneumoniae complex. Antimicrob Resist Infect Control. 2021;10(1):92. doi:10.1186/s13756-021-00944-5
* Smith CM, Hayward AC. DotMapper: an open source tool for creating interactive disease point maps. BMC Infect Dis. 2016;16:145. doi:10.1186/s12879-016-1475-5
* Moldovan ID, Suh K, Liu EY, Jolly A. Network analysis of cases with methicillin-resistant Staphylococcus aureus and controls in a large tertiary care facility. Am J Infect Control. 2019;47(12):1420-1425. doi:10.1016/j.ajic.2019.05.026
* Smith CM, Allen DJ, Nawaz S, et al. An interactive data visualisation application to investigate nosocomial transmission of infections. [version 2; peer review: 2 approved]. Wellcome Open Res. 2019;4:100. doi:10.12688/wellcomeopenres.15240.2