BLOOD BANK MANAGEMENT SYSTEM

Presentation by Dhruv Gujar

Project Agenda

- Understand the blood bank problem domain
- Explore the dataset and database structure
- Analyze blood availability and hospital demand using SQL
- Identify shortages, risks, and inefficiencies
- Derive data-driven insights for better decision-making
- Suggest operational improvements based on analysis
- Summarize findings and conclude the project

project overview

- This project focuses on analyzing a Blood Bank Management System using SQL.
- The objective is to understand blood availability, hospital demand, donor behavior, and inventory status through data analysis.
- A relational database was designed containing information about donors, blood donations, inventory, hospitals, recipients, and blood requests.
- SQL queries were used to perform data aggregation, filtering, and joins to answer real-world healthcare business questions.
- The analysis helps identify blood shortages, rare blood group risks, expired inventory, and high-demand hospitals.
- Insights derived from the project support better decision-making and operational planning for blood banks.

problem statement

Blood banks play a critical role in healthcare by ensuring the timely availability of safe blood for patients. However, managing blood inventory is challenging due to fluctuating hospital demand, limited availability of rare blood groups, blood expiry, and quality-related rejections. Inefficient tracking of donor information, inventory status, and hospital requests can lead to shortages, wastage, and delayed patient care.

This project aims to analyze blood bank data using SQL to identify availability issues, demand patterns, operational risks, and areas for improvement to support better decision-making and efficient blood bank management.

tables

Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

donor_id	full_name	age	gender	blood_group	phone	email	known_conditions	is_active
1	Allison Hill	58	M	A+	2181960013	jennifermiles@robinson-lawrence.com		1
2	Caitlin Henderson	65	M	O+	2351161559	smiller@montgomery.com	Hepatitis B Carrier	1
3	Darren Roberts	45	M	A+	3164752553	frankgray@watts.com		1
4	Andrew Stewart	19	O	A-	1395376724	zhurst@yahoo.com		1
5	Zachary Hicks	32	F	O+	0122691669	maldonadoamanda@mack-peterson.com	Hypertension	1
6	Jesse Mckay	28	O	B-	8281489325	tracy15@allen-allen.org		1
7	Angelica Tucker	39	M	A+	8227824896	pcarney@yahoo.com		1
8	Joseph Martinez	56	F	AB+	1509839301	chad34@washington.org	Thalassemia Trait	1
9	Dana Kennedy	42	M	O+	3116566701	jamesherrera@henderson.info	Diabetes Controlled	1
10	Thomas Ramos	41	O	A-	0801326773	gallowayjoseph@yahoo.com		1
11	Michael Cross	36	M	AB+	2343098050	yuchristopher@jones.com	Diabetes Controlled	1
12	Todd Hudson	47	O	AB+	9169985435	stephen10@howell-hart.com		1
13	Daniel Baker	60	F	O-	1354278498	josephpreston@tran.com	Thalassemia Trait	1
14	Mark Baker	58	M	O+	4016400524	rodriguezsierra@hotmail.com		1
15	Kimberly Davenp...	35	O	O+	6204505331	michellecherry@keith.com		1
16	Evelyn Galvan	21	M	AB+	4216073375	raymondramirez@rasmussen.com	Hypertension	1
17	Jennifer Zavala	22	M	AB-	0142940196	mlam@williams-graham.net		1
18	Kimberly Ball	31	O	B-	5615951484	jamesortega@yahoo.com	Hepatitis B Carrier	1
19	Stephanie Gilbert	27	F	A+	6804436995	yleon@jackson.org	Hypertension	1

donation_id	donor_id	donation_date	blood_group	component	units	test_status	test_details	expiry_date
1001	37	2025-07-01	A+	Whole Blood	1	Clear		2025-08-12
1002	118	2025-05-29	A+	Whole Blood	1	Clear		2025-07-10
1003	120	2025-08-17	AB+	RBC	1	Clear		2025-09-28
1004	41	2024-06-24	AB+	Whole Blood	1	Clear		2024-08-05
1005	151	2024-07-08	A-	Whole Blood	1	Contaminated	Malaria Parasite Detected	2024-08-19
1006	65	2024-12-17	O+	Plasma	1	Clear		2025-12-17
1007	99	2025-07-24	B-	RBC	1	Clear		2025-09-04
1008	98	2025-01-30	B+	Plasma	1	Clear		2026-01-30
1009	180	2025-02-22	B+	Whole Blood	1	Contaminated	Malaria Parasite Detected	2025-04-05
1010	102	2025-06-23	A+	Whole Blood	1	Clear		2025-08-04
1011	176	2025-04-09	A+	RBC	1	Contaminated	Malaria Parasite Detected	2025-05-21
1012	191	2024-10-07	AB+	Plasma	1	Clear		2025-10-07
1013	74	2024-06-22	A2B	RBC	1	Clear		2024-08-03
1014	91	2025-03-04	AB-	Whole Blood	1	Clear		2025-04-15
1015	65	2025-11-21	O+	Platelets	1	Clear		2025-11-26
1016	169	2025-03-08	A+	Platelets	1	Clear		2025-03-13
1017	25	2025-03-11	B+	RBC	1	Clear		2025-04-22
1018	80	2025-10-06	A-	RBC	1	Clear		2025-11-17
1019	94	2025-01-28	AB+	Platelets	1	Clear		2025-02-02

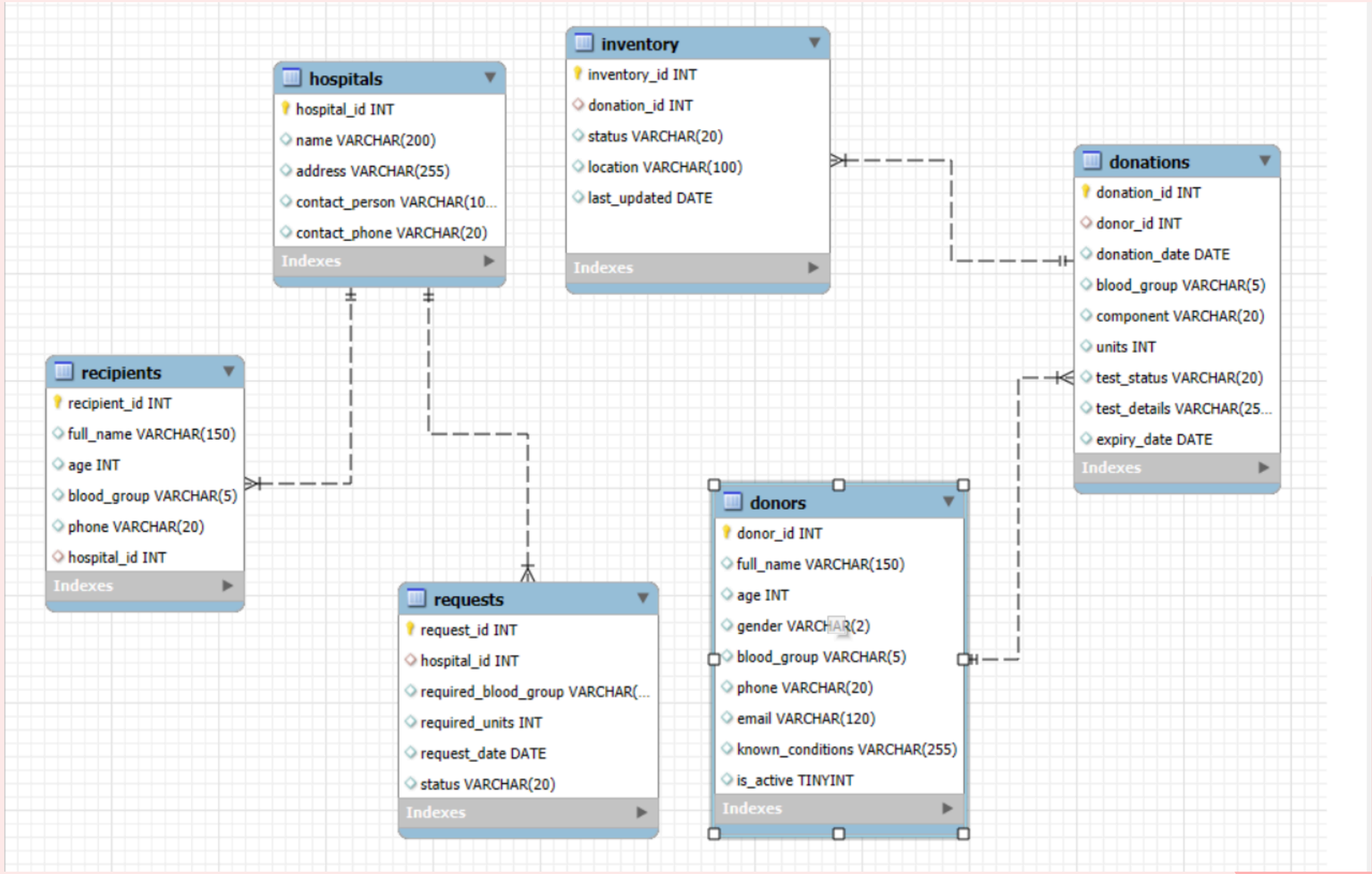
recipient_id	full_name	age	blood_group	phone	hospital_id
1	Kevin Nixon	10	O-	2847818913	4
2	Emily Brown	49	B+	8077879565	6
3	Thomas Curry	71	A-	0792904904	3
4	Sarah Ramirez	77	A2B	9444019292	11
5	Michael Washington	4	AB+	5129276637	16
6	Haley May	78	AB+	0276747836	6
7	Seth Smith	7	A-	6580185694	6
8	Dawn Silva	27	B-	3938525800	11
9	Brian Griffin	90	A2	4430091093	14
10	Larry Bennett	34	hh	1244717465	18
11	Antonio Price	39	B-	4427173962	10
12	Jessica Mendez	7	AB+	7410119470	4
13	Mary Adams	71	AB-	6908776618	19
14	Sabrina Olson	7	O-	5460158517	5
15	Tracy Guerrero	55	A-	6157173203	1
16	Arthur Fernandez MD	85	hh	0050506138	10
17	Crystal Jones	62	B-	7079032020	20
18	Sara Brown	4	B-	1799313656	4
19	Erica Oconnell	82	O+	0925114262	6

inventory_id	donation_id	status	location	last_updated
9001	1001	Expired	Freezer A	2025-10-20
9002	1002	Expired	Testing Room	2025-09-15
9003	1003	Expired	Freezer B	2025-12-02
9004	1004	Expired	Storage Rack 2	2025-01-20
9005	1005	Quarantined	Testing Room	2025-10-22
9006	1006	Available	Testing Room	2025-01-24
9007	1007	Expired	Freezer B	2025-08-02
9008	1008	Available	Testing Room	2025-04-06
9009	1009	Quarantined	Freezer B	2025-06-25
9010	1010	Expired	Testing Room	2025-11-15
9011	1011	Quarantined	Testing Room	2025-09-07
9012	1012	Expired	Freezer A	2025-02-24
9013	1013	Expired	Freezer A	2025-03-17
9014	1014	Expired	Freezer B	2025-11-22
9015	1015	Expired	Testing Room	2025-12-03
9016	1016	Expired	Storage Rack 2	2025-10-08
9017	1017	Expired	Storage Rack 1	2025-10-27
9018	1018	Expired	Freezer B	2025-11-14
9019	1019	Expired	Freezer A	2025-08-01

hospital_id	name	address	contact_person	contact_phone
1	Moore Care	790 Melanie Landing, Travisshire, KY 64831	Phillip Dixon	3920867808
2	Bryant Hospital	0036 Mark Ridge Suite 284, West Thomas, MA ...	Jeff Barnes	5647292931
3	Reynolds Hospital	270 Robert Dale, Kristenport, OH 74928	Brett Martin	4717545588
4	Jenkins Hospital	982 Kelly Spring, Hamptonmouth, CO 50448	Julie Frye	5699611253
5	Page Clinic	7598 Gutierrez Ferry Apt. 234, East Garrettville...	Allison Sanders	1492164334
6	Rose Medical Center	557 Proctor Plains, Amyberg, ND 23705	Joyce Curry	8845783174
7	Moore Medical Center	4780 Arroyo Neck, Albertchester, LA 78751	Adam Brooks	8663266341
8	Duran Lifeline	PSC 4484, Box 6312, APO AE 38458	Jesse Chavez	3502080214
9	Acosta Clinic	73564 Bolton Mountain, West Christopherberg, ...	John Lee	6013673037
10	Kennedy Lifeline	2088 Jon Route Suite 350, North Joel, MD 02475	Donald Wilson	0097925132
11	Morgan Medical Center	Unit 0052 Box 8127, DPO AE 42016	Dr. Nicole Trujillo	3065240778
12	Lopez Medical Center	7498 Casey Drives Suite 448, Shawnhaven, VA ...	Lisa Diaz	5186387829
13	Davidson Medical Ce...	22031 Lee Bypass, Barretthaven, UT 77872	Jacob Obrien	0371705865
14	Rice Care	38113 Lopez Pine Apt. 928, Reeseshire, TX 60626	Jessica Garcia	8685289755
15	Gutierrez Lifeline	398 Nicholas Plaza Suite 577, Smithton, PA 02637	Wendy Turner	3350488899
16	Stevens Clinic	9334 Davis Locks Apt. 157, South Margaret, UT...	Anna May	9610556613
17	Brown Lifeline	925 Eric Spring Suite 799, East Ryanfurt, DC 44...	Kenneth Williams	4168622783
18	Gonzalez Medical Ce...	14659 Daniel Loop, Diazborough, MI 78341	Patricia Jackson	9792703352
19	Sanchez Clinic	0514 Ruiz Isle, Lake Amanda, ND 69086	Kimberly Dean	0698042043

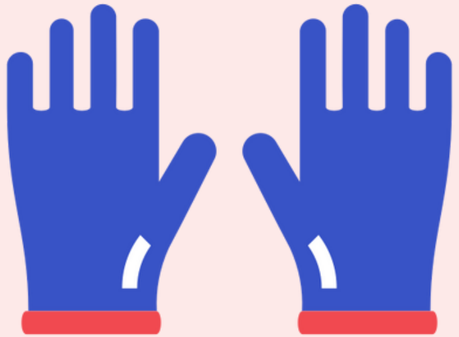
request_id	hospital_id	required_blood_group	required_units	request_date	status
5001	4	B+	2	2024-09-22	Open
5002	6	A-	1	2025-05-17	Fulfilled
5003	19	hh	1	2025-11-30	Fulfilled
5004	12	A2B	1	2025-06-17	Fulfilled
5005	5	AB-	3	2025-01-20	Open
5006	14	AB-	1	2024-09-28	Open
5007	11	A+	2	2024-11-17	Fulfilled
5008	19	A2B	1	2024-11-24	Cancelled
5009	11	A2	1	2024-11-06	Fulfilled
5010	4	AB+	2	2025-10-26	Open
5011	12	hh	2	2024-06-15	Open
5012	18	A2B	1	2025-03-16	Fulfilled
5013	6	A2	2	2025-08-29	Fulfilled
5014	6	A-	2	2024-08-26	Open
5015	11	O+	1	2025-11-16	Open

ER Diagram


hospitals
hospital_id INT
name VARCHAR(200)
address VARCHAR(255)
contact_person VARCHAR(10...
contact_phone VARCHAR(20)
Indexes
inventory
inventory_id INT
donation_id INT
status VARCHAR(20)
location VARCHAR(100)
last_updated DATE
Indexes
donations
donation_id INT
donor_id INT
donation_date DATE
blood_group VARCHAR(5)
component VARCHAR(20)
units INT
test_status VARCHAR(20)
test_details VARCHAR(25...
expiry_date DATE
Indexes
recipients
recipient_id INT
full_name VARCHAR(150)
age INT
blood_group VARCHAR(5)
phone VARCHAR(20)
hospital_id INT
Indexes
requests
request_id INT
hospital_id INT
required_blood_group VARCHAR(...
required_units INT
request_date DATE
status VARCHAR(20)
Indexes
donors
donor_id INT
full_name VARCHAR(150)
age INT
gender VARCHAR(2)
blood_group VARCHAR(5)
phone VARCHAR(20)
email VARCHAR(120)
known_conditions VARCHAR(255)
is_active TINYINT
Indexes

1. How many blood units are currently available for each blood group and component?

```
select blood_group,component,count(units) from donations group by blood_group,component;
```



blood_group	component	count(units)
A+	Whole Blood	62
AB+	RBC	23
AB+	Whole Blood	42
A-	Whole Blood	23
O+	Plasma	43
B-	RBC	18
B+	Plasma	21
B+	Whole Blood	52
A+	RBC	37
AB+	Plasma	27

2. Are there any blood groups (including rare groups like A2, A2B, hh) that are critically low in stock?

```
select
    d.blood_group,count(*) from donations d join inventory i on d.donation_id=i.donation_id
       where d.blood_group in ("A2","A2B","hh")
       and
       i.status="Available" group by d.blood_group ;
```

	blood_group	count(*)
▶	A2	1
	A2B	2
	hh	1

3.How many blood units have expired and how many are nearing expiry (within the next 7 days)?

```sql
select
    d.blood_group ,count(*) as Expired_unit  from donations d
        join inventory i on d.donation_id=i.donation_id
    where
    i.status="Expired" group by d.blood_group;
```

blood_group	Expired_unit
A+	98
AB+	82
B-	58
A2B	13
AB-	60
O+	100
B+	79
A-	34
O-	38

4.What percentage of the total inventory is available, issued, expired, or quarantined?

```
select
    status,count(*)/(select count(*) from inventory)*100
as percentage from inventory group by status;
```

	status	percentage
▶	Expired	73.3750
	Quarantined	3.7500
	Available	19.5000
	Issued	3.3750

5.How many blood donations failed the quality tests?

```sql
select count(*) from donations where test_status="Contaminated";
```

	count(*)
▶	30

5.What are the most common reasons for blood contamination?

```
select
   test_details as Most_common_reason from donations
   where test_status="Contaminated"  group by test_details limit 1;
```

	Most_common_reason
▶	Malaria Parasite Detected

6.What proportion of total donations are marked as contaminated or pending testing?

```sql
select
    round(count(*)*100.0/(select count(*) from donations),2) as Donation_propotion
from donations where test_status in ("Contaminated" ,"Pending");
```

	Donation_propotion
▶	6.00

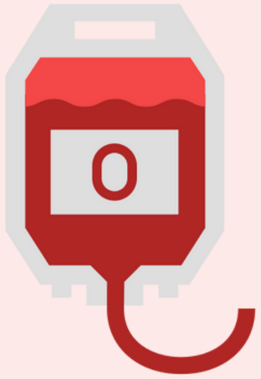
7.Are there donors whose donations repeatedly fail quality tests?

```sql
select
    full_name, count(test_status) as Failing_count from donors a
    left join donations b on a.donor_id=b.donor_id
    where b.test_status="Contaminated" group by full_name
    order by count(test_status) desc limit 3;
```

full_name	Failing_count
Miranda Gill	2
Anthony Shea DDS	2
Laura Lee	2

8.Which hospitals request the highest number of blood units?

```sql
select
     h.name  as hospital_name,sum(r.required_units) as required_units
     from hospitals h join requests r on h.hospital_id=r.hospital_id
     group by h.name order by count(r.required_units) desc limit 1 ;
```



Result Grid | Filter Rows:

hospital_name	required_units
Gonzalez Medical Center	34

9.Which blood groups are most frequently requested by hospitals?

```
select
      required_blood_group,count(required_blood_group) from requests
      group  by required_blood_group order by count(required_blood_group) desc limit 1;
```

Result Grid | Filter Rows:

required_blood_group	Required_unit
hh	33

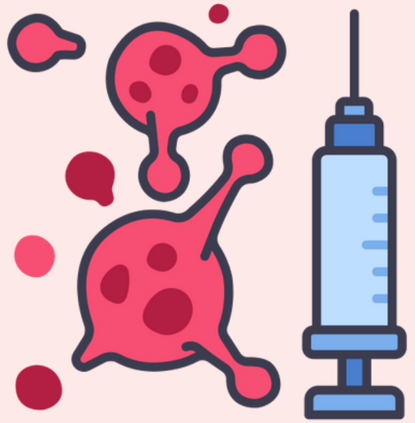
10.What is the average number of units requested per hospital request?

```
SELECT
    ROUND(AVG(required_units), 2) AS avg_units_per_request FROM requests;
```

avg_units_per_request
1.49

11.Are hospitals requesting blood that is currently unavailable?

```sql
SELECT
    r.request_id,
    h.name AS hospital_name,
    r.required_blood_group,
    r.required_units,
    COUNT(i.inventory_id) AS available_units
FROM requests r
JOIN hospitals h
    ON r.hospital_id = h.hospital_id
LEFT JOIN donations d
    ON d.blood_group = r.required_blood_group
LEFT JOIN inventory i
    ON d.donation_id = i.donation_id
    AND i.status = 'Available'
WHERE r.status = 'Open'
GROUP BY
    r.request_id,
    h.name,
    r.required_blood_group,
    r.required_units
HAVING available_units < r.required_units;
```



request_id	hospital_name	required_blood_group	required_units	available_units
5011	Lopez Medical Center	hh	2	1
5038	Morgan Medical Center	A2	2	1
5042	Morgan Medical Center	A2	2	1
5044	Page Clinic	hh	4	1
5098	Gonzalez Medical Center	A2	3	1
5135	Moore Care	A2	2	1
5202	Rose Medical Center	hh	3	1
5236	Rice Care	hh	2	1
5245	Davidson Medical Center	A2	2	1

12.Who are the top donors based on donation frequency?

```sql
select
    full_name,count(*) as Donation_frequency from donors a
join donations b on a.donor_id=b.donor_id group by a.full_name
order by count(*) desc limit 5;
```

full_name	Donation_frequency
Robert Turner	10
Miranda Gill	10
Laura Lee	9
Robert Potter	9
Anthony Shea DDS	8

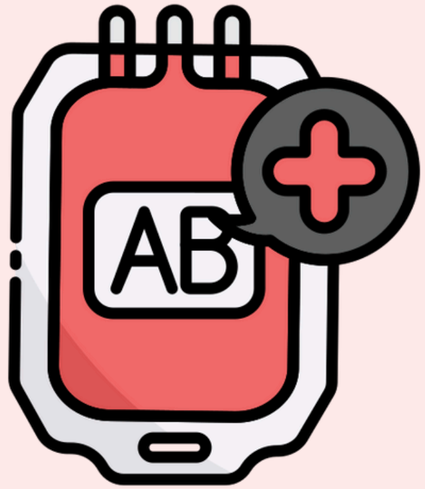
13.How many active vs inactive donors are registered in the system?

```
select
   is_active,count(*) as count from donors group by is_active;
```

	is_active	count
▶	1	186
	0	14

14.How many donors have recorded medical conditions?

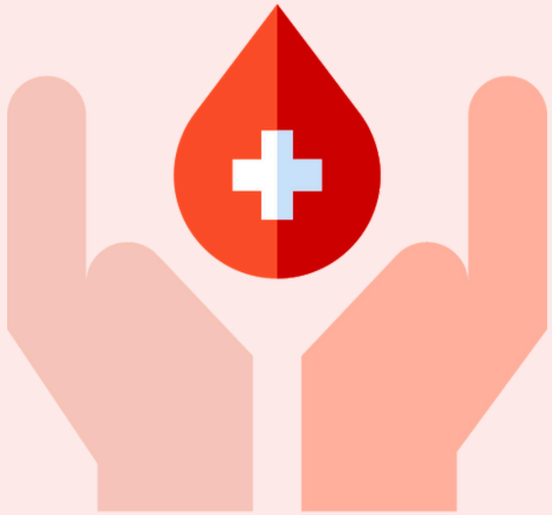
```sql
SELECT
    count(*) as Donars_cout
FROM donors
WHERE known_conditions IS NOT NULL
  AND known_conditions <> 'None'
  AND known_conditions <> '' ;
```



	Donars_cout
▶	64

15.Which hospitals request the highest number of blood units?

```
select
    h.name as Hospital_name ,count(*) as Required_units
from hospitals h join requests r
on h.hospital_id=r.hospital_id group by h.name
order by
count(*) desc limit 1;
```



	Hospital_name	Required_units
▶	Gonzalez Medical Center	19

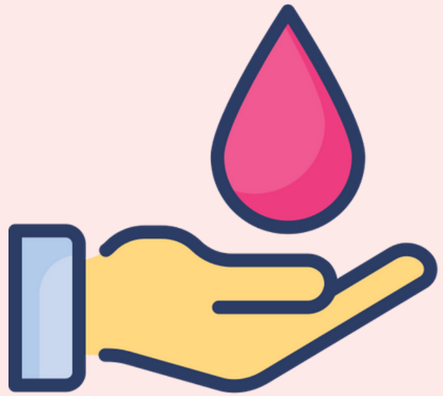
16.Which blood groups are most frequently requested by hospitals

```
select
    r.required_blood_group,count(*) as required_unit from hospitals h join requests r
    on h.hospital_id=r.hospital_id group by r.required_blood_group
order by count(*) desc limit 5;
```

required_blood_group	required_unit
hh	33
A-	26
A2	24
AB-	23
A2B	23

17.What is the average number of units requested per hospital request?

```
select round(AVG(required_units),2) as Avg_unit_requested from requests;
```



Avg_unit_requested
1.49

18.What percentage of blood requests are fulfilled, open, or cancelled?

```sql
select
  round(count(*)*100.0/(select count(*) from requests),2)
  as Percentage_of_Fullfilled_requests from requests where status="Fulfilled";

 select
   round(count(*)*100.0/(select count(*) from requests),2)
 as Percentage_of_open_requests from requests where status="Open";

 select
    round(count(*)*100.0/(select count(*) from requests),2)
    as Percentage_of_cancelled_requests from requests where status="cancelled";
```

	Percentage_of_Fullfilled_requests
▶	52.80

	Percentage_of_cancelled_requests
▶	8.40

	Percentage_of_open_requests
▶	38.80

19.Which blood groups have the highest number of unfulfilled requests?

```sql
select
    required_blood_group,count(*)as unfullfilled_count from requests
    where status="cancelled" group by required_blood_group
    order by count(*) desc limit 5;
```

required_blood_group	unfullfilled_count
A+	3
hh	3
O+	3
A-	2
AB+	2

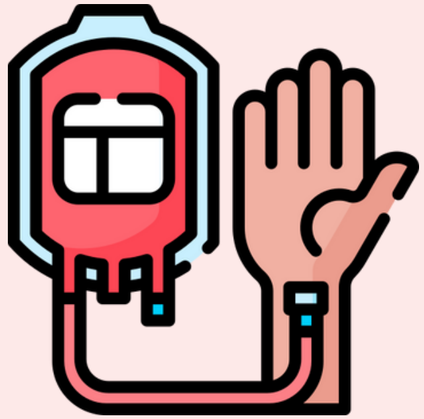
20.For open requests, is sufficient compatible blood currently available?

```sql
SELECT
    r.request_id,
    h.name AS hospital_name,
    r.required_blood_group,
    r.required_units,
    COUNT(i.inventory_id) AS available_units,
    CASE
        WHEN COUNT(i.inventory_id) >= r.required_units
        THEN 'Sufficient'
        ELSE 'Insufficient'
    END AS availability_status
FROM requests r
JOIN hospitals h
    ON r.hospital_id = h.hospital_id
LEFT JOIN donations d
    ON d.blood_group = r.required_blood_group
LEFT JOIN inventory i
    ON d.donation_id = i.donation_id
    AND i.status = 'Available'
WHERE r.status = 'Open'
GROUP BY r.request_id, h.name, r.required_blood_group, r.required_units;
```

request_id	hospital_name	required_blood_group	required_units	available_units	availability_status
5001	Jenkins Hospital	B+	2	20	Sufficient
5005	Page Clinic	AB-	3	13	Sufficient
5006	Rice Care	AB-	1	13	Sufficient
5010	Jenkins Hospital	AB+	2	18	Sufficient
5011	Lopez Medical Center	hh	2	1	Insufficient
5014	Rose Medical Center	A-	2	9	Sufficient
5015	Morgan Medical Center	O+	1	29	Sufficient
5016	Davidson Medical Center	AB+	2	18	Sufficient
5019	Moore Care	A-	1	9	Sufficient
5029	Rice Care	A-	1	9	Sufficient
5031	Moore Medical Center	O-	1	18	Sufficient
5034	Brown Lifeline	A+	1	30	Sufficient
5038	Morgan Medical Center	A2	2	1	Insufficient
5040	Kennedy Lifeline	AB-	2	13	Sufficient

21.How do blood donations vary month-wise?

```sql
SELECT
    MONTH(donation_date) AS donation_month,
    COUNT(*) AS total_donations
FROM donations
GROUP BY MONTH(donation_date)
ORDER BY donation_month;
```



donation_month	total_donations
1	43
2	57
3	33
4	46
5	49
6	73
7	88
8	93

Result 44

22. Is there a seasonal pattern in blood donation or blood demand?

```sql
select
month(request_date) as donation_month,
sum(required_units) as total_donation from requests
GROUP BY MONTH(request_date)
ORDER BY donation_month;
```

donation_month	total_donation
1	23
2	9
3	29
4	15
5	16
6	27
7	43
8	49

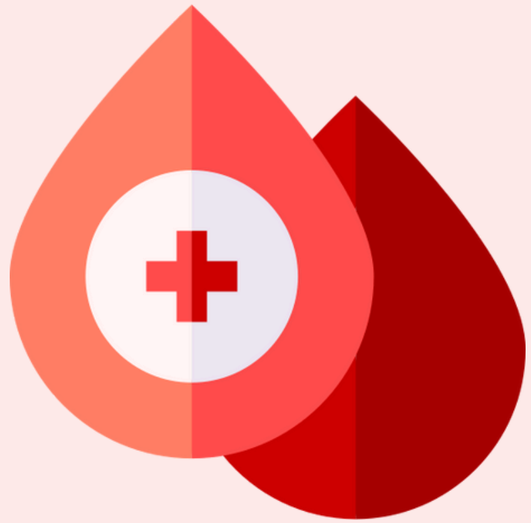
23.How has inventory availability changed over time?

```
select
month(last_updated) as  month,count(status="Available")  as availability from
inventory group by month(last_updated) order by month(last_updated);
```

	month	availability
▶	1	22
	2	18
	3	25
	4	38
	5	49
	6	48

24.Are rare blood groups donated less frequently compared to common groups?

```sql
SELECT
    case
        when blood_group in ("A2B","A2","hh")
        then 'rare'
        else 'Common'
        end as Blood_group_type,
        count(*) as donation
        from donations
        group by Blood_group_type
        order by donation ;
```



Blood_group_type	donation
rare	45
Common	755

25.What operational improvements can be suggested based on data analysis?

- Target rare blood group donors
- Reduce blood expiry through better rotation
- Monitor demand vs availability regularly
- Expand and diversify donor base
- Improve quality screening process
- Plan seasonal donation drives
- Prioritize high-demand hospitals
- Maintain real-time inventory tracking
- Create emergency donor contact lists
- Use data for continuous improvement

Conclusion

- This project demonstrated how SQL can be effectively used to analyze real-world healthcare data.
- The analysis provided insights into blood availability, hospital demand, donor behavior, and inventory status.
- Key issues such as rare blood group shortages, expired inventory, and unfulfilled hospital requests were identified.
- Data-driven findings highlighted the need for better inventory management, targeted donor drives, and demand-based prioritization.
- Overall, the project shows how structured data analysis can support efficient blood bank operations and informed decision-making.

Thank You