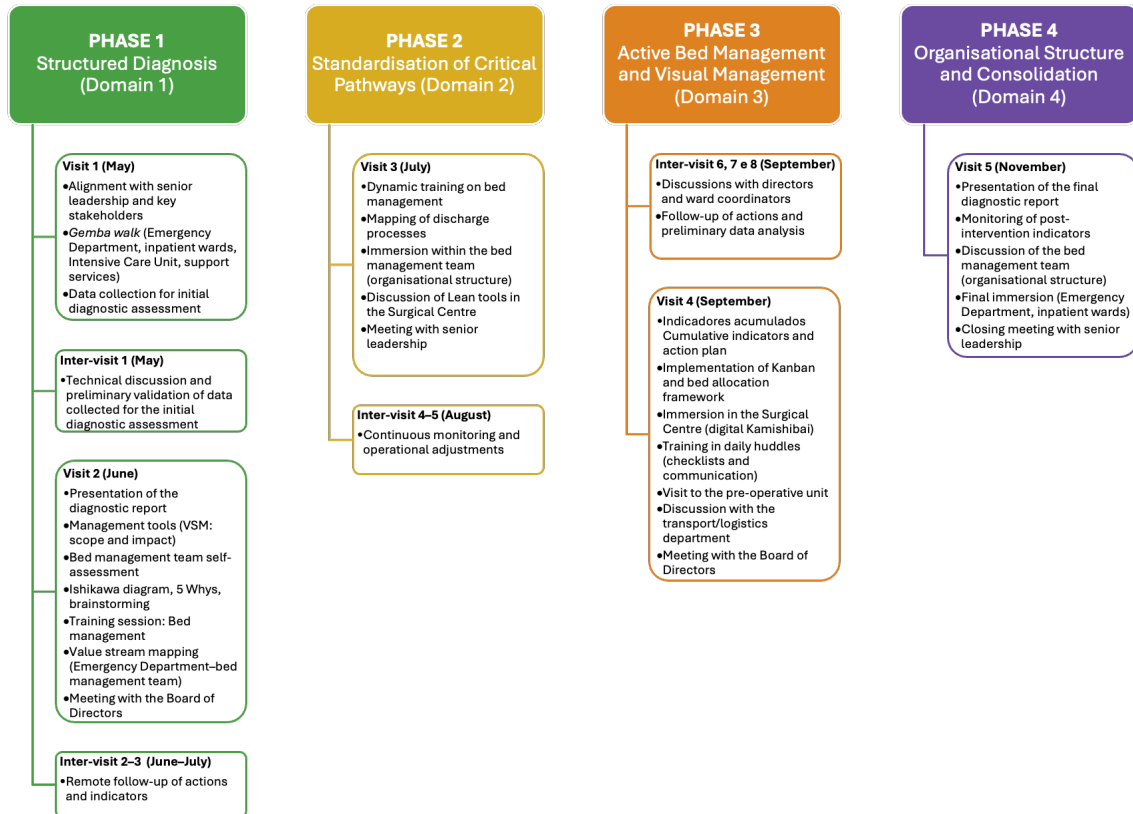


Supplementary Material

Supplementary Figure 1 – Structure and timeline of the intervention for improving hospital flow and bed management



The intervention was structured into four sequential phases, organised across four interrelated operational domains. Implementation activities took place between May and August 2025, followed by a consolidation and monitoring period between September and October 2025, which was considered the post-intervention period for analytical purposes. The pre-intervention period (March–April 2025) was not included within the intervention phases.

Supplementary Table 1 – Monitored indicators and their operational definitions

EMERGENCY		
Indicator	Unit of Measurement	Description
Number of visits/month	Absolute number	Total number of patient visits to the Emergency Department during the analysed period.
Number of admissions/month	Absolute number	Total number of patients seen in the Emergency Department who were subsequently admitted to hospital.
Number of visits/day	Absolute number	Total number of visits divided by the number of days in the corresponding period.
Number of admissions/day	Absolute number	Total number of hospital admissions originating from the Emergency Department divided by the number of days in the period.
Emergency department length of stay (non-admitted patients)	Minutes	Average time from patient arrival at the Emergency Department to discharge home without hospital admission.
Total emergency department length of stay until admission to an inpatient bed	Minutes	Average time from patient arrival at the Emergency Department to admission to an inpatient bed. For patients with a decision to admit who subsequently die or are transferred, the time until exit from the Emergency Department after outcome determination is considered.
Boarding time	Minutes	Average time between the medical decision to admit and admission to an inpatient bed or exit from the Emergency Department following administrative processing (e.g. death or transfer).
Mortality within 24 hours	Percentage	Percentage of deaths occurring within the first 24 hours after Emergency Department attendance, using total discharges (including admissions, transfers, and deaths) as the denominator.
Left without being seen rate	Percentage	Percentage of patients who completed initial administrative registration but left before medical assessment.
INPATIENT UNITS (WARDS AND ICUs)		
Indicator	Unit of Measurement	Description
Overall average length of stay	Days	Average duration of hospitalisation across all units (wards and ICUs). Formula: Total inpatient days ÷ Total discharges (including deaths and external transfers).
Average length of stay (wards)	Days	Average length of stay for patients admitted to medical and surgical wards. Calculated at ward level. Formula: Total ward inpatient days ÷ Total ward discharges.
Average length of stay (ICUs)	Days	Average length of stay for patients admitted to intensive care units. Formula: Total ICU inpatient days ÷ Total ICU discharges.
Bed occupancy rate	Percentage	Percentage representing the average occupancy of operational hospital beds. Formula: (Total inpatient days ÷ [Number of operational beds × number of days in the period]) × 100.
Bed turnover rate	Absolute number	Average number of patients admitted per bed during the analysed period. Formula: Total discharges ÷ Number of operational beds. Reflects how often each bed was used.
Bed turnover interval (overall)	Minutes	Average time a general hospital bed remains unoccupied between the discharge of one patient and admission of the next. Formula: [(Available beds × days in period) – inpatient days] ÷ number of discharges.
Bed turnover interval (wards)	Minutes	Average time a ward bed remains unoccupied between patients. Formula: [(Available beds × days in period) – occupied days] ÷ number of discharges.
Bed turnover interval (ICUs)	Minutes	Average time an ICU bed remains unoccupied between patients. Formula: [(Available beds × days in period) – occupied days] ÷ number of discharges.
Number of discharges/day	Absolute number	Average number of hospital discharges per day during the analysed period. Formula: Total discharges ÷ number of days.
Discharges by 12:00 per day	Percentage	Percentage of hospital discharges completed by midday, an important indicator for improving bed turnover. Formula: (Discharges completed by 12:00 ÷ Total discharges) × 100.

SURGICAL CENTRE		
Indicator	Unit of Measurement	Description
Number of surgeries/month (emergency and elective)	Absolute number	Total number of surgical procedures performed during the period, stratified into emergency and elective surgeries.
Number of surgeries/day (emergency and elective)	Absolute number	Average daily number of surgical procedures performed. Formula: Total surgeries ÷ Number of working days (or total days in the period, depending on analysis).
Same-day surgery cancellation rate (D0)	Percentage	Percentage of surgeries cancelled on the scheduled day of the procedure (day zero), regardless of cause (clinical, administrative, or logistical). Formula: (Number of cancellations on D0 ÷ Total scheduled surgeries) × 100.

Supplementary Table 2 – Monthly trend estimates (simple linear regression) for the four primary indicators, March–October 2025.

Indicator	Slope/month	95% CI	p (unadjusted)	p (Bonferroni, $\alpha=0.0125$)
Time to admission (min)	–22.8	–42.2 to –3.4	0.028	Not significant
Boarding time (min)	–24.0	–40.1 to –7.8	0.011	Significant
Bed turnover interval (min)	–13.7	–27.2 to –0.3	0.047	Not significant
Discharges by 12:00 (%)	+0.77 pp	+0.48 to +1.07	<0.001	Significant

Simple linear regression model, with study month (1–8) as the independent variable. P-values are presented with and without Bonferroni correction for the four tests performed. Given the small number of monthly observations and the possible autocorrelation between consecutive months, these estimates should be interpreted as an exploratory complement to the run charts (Section 2.6), and not as independent statistical confirmation.

Supplementary Table 3 – Temporal evolution of operational indicators throughout the study period

EMERGENCY								
Indicator	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Number of visits/month	8,698	8,306	8,692	8,693	9,463	9,176	8,651	9,082
Number of admissions/month	1,011	984	960	936	1,050	1,009	942	955
Number of visits/day	281	277	280	290	305	296	288	293
Number of admissions/day	33	31	31	31	34	33	31	31
Emergency department length of stay (non-admitted patients)	306	308	280	283	307	303	309	301
Total emergency department length of stay until admission to an inpatient bed	864	753	734	646	744	733	662	642
Boarding time	395	301	278	199	264	269	206	170
Mortality within 24 hours	0.10%	0.05%	0.15%	0.12%	0.16%	0.08%	0.15%	0%
Left without being seen rate	5.20%	4.85%	4.46%	4.39%	5.58%	5.44%	4.90%	4.80%
INPATIENT UNITS (WARDS AND ICUs)								
Indicator	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Overall average length of stay	6.2	6.4	6.7	6.6	6.2	6.5	6.5	6.3
Average length of stay (wards)	6.2	6.4	6.7	6.6	6.2	6.5	6.5	6.4
Average length of stay (ICUs)	6.2	3.1	4.9	4.9	7.6	7.1	3.6	4.1
Bed occupancy rate	91%	94%	96%	90%	97%	87%	97%	94%
Bed turnover rate	4.4	4.2	4.3	3.9	4.7	3.9	4.2	4.4
Bed turnover interval (overall)	465	564	518	495	466	469	451	406
Bed turnover interval (wards)	445	546	489	471	447	444	436	381
Bed turnover interval (ICUs)	1,215	1,349	1,434	1,206	1,157	1,325	1,120	1,198
Number of discharges/day	55	54	53	51	58	50	55	55
Discharges by 12:00 per day	9%	11%	11%	12%	12%	12%	15%	15%
SURGICAL CENTRE								
Indicator	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Number of surgeries/month (emergency and elective)	867	776	860	741	934	701	847	859
Number of surgeries/day (emergency and elective)	35	33	33	32	35	33	38	37
Same-day surgery cancellation rate (D0)	7.10%	7.30%	7.30%	5.10%	4.50%	7.40%	5.30%	5.30%

Values are presented as monthly averages. The pre-intervention period corresponds to March-April 2025, and the post-intervention period to September-October 2025. Data are presented for descriptive purposes.